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PROCEEDINGS

—OF THE—

CONNECTICUT
Civil Engineers and Surveyors
ASSOCIATION,

—AT ITS—

SUMMER MEETING,

—HELD AT—

HOLYOKE, MASS., JULY 18, 1899,

—AND ITS—

SIXTEENTH ANNUAL MEETING,

—HELD AT—

HARTFORD, CONN., JAN. 9, 1900.

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CONNECTICUT
Civil Engineers and Surveyors
ASSOCIATION.

ORGANIZED AT BRIDGEPORT, JANUARY 15, 1884.

OFFICERS FOR 1900.

President—EDWIN D. GRAVES, Hartford.
First Vice-President—HENRY J. KELLOGG, New Haven.
Second Vice-President—CLARENCE B. VORCE. Hartford.
Secretary aud Treasurer—GEO. K. CRANDALL, New London.
Assistant Secretary—EDWARD W. BUSH, Hartford.

EXECUTIVE COMMITTEE.

EDWIN D. GRAVES, Hartford.
FREDERICK L. FORD, Hartford.
GEO. H. BISHOP, Middletown.
HERBERT C. KEITH, New Haven.
A. J. PATTON, Waterbury.

MEMBERSHIP COMMITTEE.

D. E. BRADLEY, East Berlin.
JOHN C. TRACY, New Haven.
CHAS. E. CHANDLER, Norwich.

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THE SUMMER MEETING

OF THE

CONNECTICUT CIVIL ENGINEERS AND SURVEYORS ASSOCIATION,

HELD AT

HOLYOKE, MASS., JULY 18, 1899.

An unusually large representation of the members of The Connecticut Civil Engineers and Surveyors Association gathered at the Hartford depot of the N. Y. N. H. & H. R. R., Tuesday morning, July 18th, and at half past nine were taken by regular train to Springfield, Mass., in accordance with a program for the day's outing which had been carefully arranged to provide an admirable trip, and whose details and provisions had been prearranged so thoroughly and efficiently that the calendar was realized with complete success, and afforded thorough enjoyment without any of the drawbacks or disappointments so often attending functions of this kind.

Special rate tickets were received and the members, distinguished by tasteful badges, filled their handsome special car and enjoyed their cigars, while greeting old friends and making new ones of all their brethren and guests, whose presence afforded special opportunity for informal meetings which were not neglected during the trip. The material conditions were worthy of the well planned outing and its exceptional attendance, and all the charms of a delightful summer day, bright and balmy, with a delicious breeze and unimpeachable temperature, united with the social conditions to develop the fullest enjoyment of the beautiful panorama of the Connecticut valley that was unveiled before the car windows. Luxuriant summer foliage, hills, valleys, and charming towns, made a varied setting for the noble river, and from time to time a local member would add still further interest by pointing out historic points or special objects, notable among which was the famous warehouse bridge, a deck Warren girder of one 200-foot and eleven 110-foot spans, built in the fifties, erected by an English workman imported for the occasion, and although one of the first wrought iron bridges in the world, still doing excellent service long after many of its juniors have been superceded by stronger structures.

At Springfield, the party, reinforced by some additions, became the guests of The Holyoke Water Power Company and of Mr. Arthur McMullen, contractor for the new Holyoke dam. They hastily viewed the much discussed Main Street railway arch, with its remarkably flat intrados and deep Voussoirs, and proceeded to the special electric cars, which for several miles sped them through suburban and country streets not less attractive than the former landscapes, through Holyoke and to the foot of Mount Tom, where a transfer was made to the cars of the inclined plane which afforded points of technical interest, with its curved tracks of 21 per cent. grade and ingenious cars over rails where an extra set of outside wheels carried each car over the intersecting cable and where the cars themselves attached to opposite ends of a single cable, which passed freely around a sheeve at the head of the incline, were made to balance their own dead loads and so utilize all their motive power for propelling their proportionately small live loads up the grade.

At the top of the mountain the party rendezvoused at the Summit House and there on the spacious sheltered piazzas, overlooking many miles of a vista which included notable mountain peaks, numerous cities and towns, and parts of three states, they did full and willing justice to an admirable luncheon, well served and thoroughly appreciated. Many of those present were familiar with the surrounding country, and during the period of coffee and cigars pointed out the different landmarks to those who were less familiar with them. Adjournment to the observatory widened the horizon and enabled it to be inspected through a number of field glasses and mounted telescopes, through which nearly forty important towns could be examined and a dozen prominent peaks surveyed, besides enjoying the prospect of the Connecticut Valley and all the succession of field and forest and hill and valley that extended in every direction in a view said to be most beautiful and diversified in the State, and which was certainly seen under the most auspicious conditions.

If any incentive was needed to promote the fraternity of the company, it was supplied by the constant change of groups as the hours carried them from train to cars, to incline, to lunch, and to the visiting that followed, so that eventually the great desideratum of such a trip was well achieved in securing the companionship of almost every person with all the rest, and the formation of many new acquaintanceships that could not else have been made.

A brief business meeting was held, at which the following new members were elected :—

Harry A. Storrs of Burlington, Vt. ; Frank W. Hoyt of Hartford, Conn.; Charles H. Olmsted of East Hartford ; Harry C. Collins of Springfield, Mass.; Henry A. Wolcott, Herbert G. Clark, Roscoe N. Clark, John P. Murphy, Thomas C. B. Snell, Frank W. Loomis, George B. Rogers, George A. Parker, Charles M. Crawford, Norman McD. Crawford, Theodore Wirth, Edward M. Stone and John T. Henderson all of Hartford Conn.; Julius L. Adams of South Manchester, Conn.; Fred T. Ley of Springfield, Mass.; Arthur L. Davis of East Berlin, Conn.

It was voted that the President appoint a committee of three to draw up suitable resolutions to be presented to the Holyoke Water Power Company and to Mr. Arthur McMullen, contractor, thanking them for their courtesies and attention on this occasion.

The President appointed as such committee, Messrs. Charles M. Jarvis, Robert A. Cairns and Charles H. Bunce.

The following resolutions were drawn up and sent to the Holyoke Water Power Co. and Arthur McMullen, by the Secretary as directed :

WHEREAS, It was the unanimous opinion of the members of the Connecticut Civil Engineers and Surveyors Association, and of their invited guests, that the Summer Meeting, held at Holyoke, was the most successful and enjoyable one on record ; and,

WHEREAS, This was entirely due to the open-hearted hospitality of the Holyoke Water Power Company and of Mr. Arthur McMullen, contractor ; therefore be it,

Resolved, That the thanks of this Association be tendered to The Holyoke Water Power Company and to Mr. Arthur McMullen, for all their courtesies and attention on that occasion ; and be it further

Resolved, That a copy of these resolutions be attested by the Secretary of the Association and forwarded to the President of the Holyoke Water Power Company, and to Mr. Arthur McMullen.

(Signed).
CHARLES M. JARVIS, }
ROBERT A. CAIRNS, } *Committee.*
C. H. BUNCE, }

After the business meeting the party commenced their return by visiting the new dam, now being built to replace the famous timber structure built fifty years ago to which much of the city's prosperity is due. The new dam is a mass of solid masonry over 1,000 feet long, 30 feet high and 66 feet wide, built on the bed rock of the river bottom, at a cost of over half a million dollars. The work in progress illustrated nearly every phase of the construction and displayed advanced methods and high grade equipment. The members inspected it carefully with the realization that the work is noted for its remarkable excellence and the unusual requirements of its specifications. The conspicuous excellence elicited much professional admiration, but the members were not as a rule convinced that such costly requirements were often practicable. Some of the most striking features of the work were; the systems of handling material, of leveling, abeying and battering each stone, of grouting and bedding the face stones, and of providing for the flood water and building coffer dams; all of which were illustrated and described in an account of the excursion which was published by The Engineering Record.

While the dam was being inspected, a small party was formed to witness a water-wheel test made in their behalf, and at a regretfully early time the visitors were obliged to depart for trolley and trains to different points, many of them separating at Springfield and the remainder going together as far as Hartford.

Over one hundred and twenty members and guests made an unprecedented attendance and united in according to the day's entertainment the distincion of having been the most satisfactory, pleasant and interesting of all successful excursions, and the appreciation felt and expressed justified the good judgment, work and careful planning and arrangement of details, so faithfully performed by the President and Committee, as well as the hospitality extended by their hosts.

Acknowledgment is also due to the officials at Holyoke, Hon. C. E. Gross, president of the Water Power Company, Edward S. Waters, treasurer and hydraulic engineer, James M. Sickman, engineer in charge, Robert Raulet and W. E. Sawin, assistant engineers, and F. M. Talbot, superintendent.

The guests of the Association for the day included Senator E. S.

Goodrich president of the Hartford Street Railway Company, Ex-Lieutenant-Govenor Ernest Cady, C. W. Roberts of the Bridge Commission, Norman McD. Crawford, general manager of the Street Railway Company, Charles M. Crawford of the Hartford Paving and Construction Company, Hiram Bissell and Mr. Brett of Holyoke, Frank W. Skinner of the Engineering Record, and J. M. Bigsby of the Scientific American.

The following members and guests were present:—

Edwin D. Graves, Charles E. Gross, John P. Murphy, Frederick L. Ford, M. A. Butt, W. E. Johnson, Ernest Cady, J. S. Chase, J. S. Hunter, E. S. Goodrich, H. G. Clark, Wm. E. St. John, M. H. Moyer, C. B. Vorce, Henry Souther, Everett S. Geer, J. L. Adams, Halbert G. Robinson, John T. Henderson, T. A. B. Snell, Charles M. Crawford. Norman McD. Crawford, H. G. Loomis, Frank W. Loomis, Edward W. Bush, E. M. Stone H. A. Wolcott, G. A. Parker, R. N. Clark, Theodore Wirth, E. M. Peck, C. E. Beach, F. H. Stadtmueller, Robert R. Smith, Ralston Smith, A. B. Alderson, C. H. Olmsted, C. W. Roberts, W. H. Olmsted, E. P. Augur, H. B. Tabor, Charles M. Jarvis, J. H. Edwards, W. H. Edwards. Frederick DePeyster, H. L. Davis, H. L. Hirons, E. A. Keeney, John T. McKnight, R. A. Cairns, Wm. F. Chatfield, A. J. Patton, A. R. Wadsworth, E. T. Carrington, L. E. Daboll, Geo. K. Crandall, Geo. E. Manning, T. H. McKenzie, S. C. Pierson, Roswell Atkins, S. E. Minor, Shepard B. Palmer, Charles E. Chandler, R. S. Bartlett, H. A. Storrs, Edward S. Waters, J. M. Sickman, W. E. Sawin, Edward Walther, A. F. Sickman, James F. Sickman, J. W. Bigsby, Arthur McMullen, Frank W. Skinner, Edward C. Haynes, Harry C. Collins, J. A. Kirby, Richard S. Kirby, Alfred deFries Demer, Henry W. Ayers, Edmund Brown, C. H. Bunce, L. W. Burt and Wm. B. Palmer.

PROCEEDINGS

OF THE

SIXTEENTH ANNUAL MEETING

OF THE

CONNECTICUT CIVIL ENGINEERS AND SURVEYORS ASSOCIATION,

HELD AT

HARTFORD, CONN., JANUARY 9, 1900.

The sixteenth annual meeting of the Association was held in the Council Chamber, in the City Hall, at Hartford, Conn., January 9, 1900.

The meeting was called to order at 11 o'clock in the forenoon by President Edwin D. Graves.

The minutes of the last annual meeting were approved as printed.

The minutes of the summer meeting held at Holyoke, Mass., were read and approved.

THE PRESIDENT. I invited Mr. Waters, engineer of the Holyoke Dam, to come here to the meeting today, and he sent me a postal card, in which he says: "I regret I shall be unable to avail myself of your kind invitation. You will all, I hope, be glad to learn that the masonry of the Holyoke Dam will be completed this week"—that is, last week. I was informed, yesterday, by Mr. Gross, the President of the Holyoke Water Power Company, that it was completed last week, and the last stone laid.

The Secretary then read his annual report as follows:

SECRETARY'S REPORT.

NEW LONDON, CONN., January 9th, 1900.

To the Officers and Members of the Connecticut Civil Engineers and Surveyors Association:

GENTLEMEN:—The fifteenth year in the history of our Association now drawing to a close, has certainly been a very prosperous one, for we have had two very interesting and instructive meetings, our funds have reached a point never before attained, and we have had an unprecedented increase in our membership. During the past year thirty-one new members have been added to our list.

The membership now comprises five (5) honorary, one (1) contributing and one hundred (100) active members, making a total of one hundred and six (106).

The proceedings of our last annual meeting and the summer meeting held at Bristol in 1898, have been printed and sent out to the members and the Associations with which we exchange.

The reports received in exchange have also been mailed to our members.

The summer meeting held at Holyoke, Mass., was of great interest to the members, as was evidenced by the large attendance. A full report of this meeting will be printed in the next annual report.

Respectfully submitted,

GEO. K. CRANDALL, Secretary.

It was voted that the report of the Secretary be approved and ordered printed in the annual report of the Association.

The Treasurer then read his annual report as follows:

TREASURER'S REPORT.

For the Year ending January 9th, 1900.

GEO. K. CRANDALL, Treasurer, in account with the Connecticut Civil Engineers and Surveyors Association.

RECEIPTS.

Cash on hand January 10th, 1899	$437.25	
Received for advertisements	327.00	
Received for dues	222.00	
		$986.25

DISBURSEMENTS.

Janitor at Hartford	$ 2.00	
Stenographer	15.00	
Printing	277.46	
Postage, stationery, etc.	65.51	
Freight and cartage	5.35	
Geo. K. Crandall, salary as secretary	25.00	
Cash on hand January 9th, 1900	595.93	
		$986.25

Respectfully submitted,

GEORGE K. CRANDALL, Treasurer.

It was voted that the report of the Treasurer be approved and ordered printed in the annual report of the Association.

Mr. Frederick L. Ford then read the report of the Executive Committee as follows:

REPORT OF EXECUTIVE COMMITTEE.

HARTFORD, CONN., December 14, 1899.

Upon the call of the President every member of the Executive Committee met in Hartford, December 14th, for the consideration of business relative to the coming annual meeting of our society. The meeting was organized, and F. L. Ford elected clerk.

The first important business presented was the selection of an appropriate place for holding our annual dinner. Several propositions were entertained, and after a careful and impartial discussion of the subject, it was unanimously voted to accept the offer of the Allyn House management, they agreeing to furnish us with a dinner in harmony with the newly remodeled Allyn House, and the use of the two large connecting dining rooms on the second floor for the exclusive use of the society during the afternoon for $2.75 per capita. Each member present to be assessed $1.50, the balance paid from the treasury.

The idea of having the papers read and discussed around the dinner table originated with our President. This new departure from past customs seemed very desirable to the committee and worthy of at least a fair trial. It is hoped that the informality of the dining room, and close proximity of audience and speakers, will stimulate a free and instructive discussion of the subjects presented.

Mr. Graves and Mr. Ford were delegated with authority to arrange all details for the proper accommodation of our guests and members.

Our President, Mr. Graves, next presented for the perusal of the committee, a convenient pocket guide of the Civil Engineers Club of Philadelphia, which contained a full list of all members with their official occupations and addresses, constitution, by-laws, a list of deceased members, etc.

As the supply of our constitution and by-laws is nearly exhausted, and another supply will have to be secured in the immediate future, it was considered desirable to see if our next set cannot be edited to advantage in a form similar to the sample exhibited. Mr. Graves was authorized to investigate.

In connection with the republication of our constitution and by-laws it was suggested that a few amendments be considered, increasing the scope of our society. One was the desirability of having a nominating committee to prepare a list of officers, and send out mailing blanks in advance of each annual meeting, so that all members may have a chance to consider the qualifications of the officers selected, and be able to vote quickly and intelligently at the meetings. Mr. Graves was selected to prepare the amendment for the consideration of the society. It was then voted that Mr. Graves and Mr. Ford prepare an amendment to section 2 of Article I of our constitution, increasing the number of engineering professions allied to our society, many of which have members who would make desirable additions to the society.

Next voted that the Secretary of our society send a copy of our annual report to all engineers in the State eligible to membership in our society.

A bill of $12.75 was presented by Smith & McDonough for letter heads and approved.

No further business, meeting adjourned.

All matters before the committee which need the consideration of the society will be presented, separately, under new business.

Attest—

FREDERICK L. FORD, Clerk.

HARTFORD, CONN., January 9, 1900.

This is to certify that we have examined the accounts of George K. Crandall, Treasurer, comparing the bills with vouchers for same and find them correct.

We have also examined the bank book, and find the credit as shown by report to agree with balance in bank.

A. J. PATTON,
F. L. FORD,
EDWIN D. GRAVES,
Executive Committee.

It was voted that the report be accepted and ordered printed in the annual report of the Association.

The several special committees of the Association then read their reports which were accepted. (These reports will be found printed in full in this book).

Forty-four applications for active membership in the Association were received, and referred to the Membership Committee. After a favorable report from the Membership Committee, it was voted that the report of the committee be accepted and the Secretary was instructed to cast one ballot for the applicants so reported on as active members of the Association.

In accordance with this vote the Secretary then cast one ballot in favor of Arthur A. Adams, James P. Bogart, Richard M.

Berrian, Samuel E. Barney, Clarence Blakeslee, Alexander Cohn, Richard O. Cheney, Jr., Fayette S. Curtis, Harry E. Carlisle, Theodore I Coe, Solomon LeF. Deyo, Augustus J. DuBois, Chas. W. Eddy, Charles H. Ewing, Charles A. Ferry, Edward Gagel, Henry H. Gladding, George W. F. Gillette, Albert B. Hill, Morrison C. Hamilton, J. Frederick Jackson, Herbert M. Knight, Cassius W. Kelly, Herbert C. Keith, Frederick P. Lewis, Frank A. Maloney, Charles W. Merrel, William H. Moore, Robert E. Mitchell, Edward S. Nettleton, Paul Nash, Fred H. Osborn, John K. Punderford, Robert W. Rollins, William Lispenard Robb, Ely M. T. Ryder, A. William Sperry, Walter T. Spencer, Raymond F. Stoddard, James B. Thomas, John C. Tracy, Max J. Unkelbach, Edward T. Ward, Charles Lewis Young, Jr., and they were duly declared elected as active members.

The Association then proceeded to the election of officers for the ensuing year. John T. Henderson and C. H. Olmsted were appointed as tellers.

The following officers were declared elected :

Edwin D. Graves, Hartford,	*President*
Henry J. Kellogg, New Haven,	*First Vice President*
Clarence B. Vorce, Hartford,	*Second Vice President*
Geo. K. Crandall, New London,	*Secretary and Treasurer*
Edward W. Bush, Hartford,	*Assistant Secretary*

EXECUTIVE COMMITTEE.

Edwin D. Graves, (*ex officio*)	Hartford
Frederick L. Ford,	Hartford
George H. Bishop,	Middletown
Arthur J. Patton,	Waterbury
Herbert C. Keith,	New Haven

MEMBERSHIP COMMITTEE.

D. E. Bradley,	East Berlin
John C. Tracy,	New Haven
Charles E. Chandler,	Norwich

The president then read his address as follows:

PRESIDENT'S ADDRESS.

The custom heretofore has been for the President in his annual address to give a summary of all the work done throughout the State during the year which had closed, and I feel that I owe an apology to you for not being able to present such a report at this time. I have sent out circulars, asking for information from each member to make up this report and have received a great many valuable and concise replies, but I do not feel that a summary of these replies would represent in any measure the work done in the State, and I feel that anything which does not represent all the work is misleading and ought not to be published in the form of a report. I believe that a report showing the amount of work done during the year and giving some considerable detail in regard to the more important pieces of work, would be a very valuable record to be preserved in our publication, and I hope that before another year goes by we can evolve some scheme by which this information can be secured with a fair degree of accuracy, at least with sufficient accuracy to represent to the public the enormous value of work done in this State each year under the direction and supervision of members of this Association. Before the annual report is published we will endeavor to secure such additional information as will cover to a great extent the most important work done during 1899 and publish some sort of a summary in the report, but today I am not able to give you this summary.

At the beginning of the year I appointed in addition to the regular committees a number of committees to represent branches of engineering work which had never been represented by a committee, with the idea of having each class of work throughout the State covered by a report from the committee whose special duty it is to watch and keep a record of such work. As this was the first year and the action was something of an experiment, there arose naturally many cases of misunderstanding as to what was to be done and a great difference in effecting the committee work, but I can see that if this method is carried out in all cases as completely as has been done by one or two committees, there is going to be serious annoyance to the members, as well as considerable expense to the Association, due to the duplication of circular letters, as the secretary or chairman of each committee, as they may choose, must necessarily send a circular letter to every member of the Association and this will entail the filling out of ten or twelve circulars by each member, which I have an idea would be seriously objected to. At least I should feel that it was unnecessary myself. My suggestion to overcome this difficulty is, that the office of Assistant Secretary be filled by some one whom the President may select, residing in the same town, and who can give considerable time throughout the whole year to the collection of this data, and at the proper time send out one circular with proper blanks which will secure all the information in all classes at one time. The working up and tabulation of this shall also be a part of his duty, and if the amount of work seems sufficiently large to warrant it, there might be some remuneration voted to this office at the end of the year.

The close of the year 1899 marks a very important epoch in the affairs of this country. We have, as a nation, taken a new place among the great nations of the earth, and business prosperity has been almost unprecedented. We have seen prices assume their normal level and in many cases rise above it. Such prosperity in general business brings good times to our profession and the natural result of these good times and general financial prosperity among our members is reflected in the tone of the replies received by me regarding the work of the past year, and the very promising outlook for the year 1900. In many cases the prediction was made that we should see during this year the most prosperous year for engineers in the history of this country. The many cases where members were so busy that they could hardly find time to reply to my letters of inquiry, while being disappointing in one sense, were also very good indications that we are not generally lacking for employment.

Some members have not been able to reply in any way to repeated letters, and I believe that to such a word of caution should be sent, calling their attention to the dangerous results of overwork. With the many cases of nervous prostration, superinduced by overwork which we see every day they should be forewarned in time. But seriously, members should remember that, as members of this Association, a small percentage of their time is due the Association to make its reports and records and meetings successful, and I cannot believe that there is any member so busy that he cannot afford one or two days out of the year to give attention to these matters; and it is a fact to be noted that such of the engineers in this State who have the greatest amount of work on hand and who conduct the greatest volume of business in the year, take the pains to make the most concise and systematic replies to all letters.

Attendance at the meetings is also important, not only for the enthusiasm which results from such meetings, but also for the acquaintances which are made and the feeling of good fellowship which is stimulated by such meetings. I believe it is one of the prime objects of such an Association to make members better acquainted and less inclined to sectionalism. In fact, the first article in the Constitution after the name of the Association provides that:

"The object of this Association shall be the professional improvement of its members, the encouragement of social intercourse among men of practical science, and the advancement of engineering in its several branches."

You will notice that in this paragraph the social intercourse is put before the advancement of engineering science, and while I would not in any measure detract from the value of study and investigation and discussion of engineering subjects, I do believe that the province of this Association is more largely in the line of forming acquaintances and becoming interested in each other, than in the abstract and deep discussion of scientific problems. I have in the last few weeks been asked by prospective members what the object of such an Association is. Members of the American Society of Civil Engineers say that, with those discussions on technical subjects, they do not see the value of joining another and smaller Association whose proceedings of course can never approach the level, in the point of scientific work, of the Association before mentioned. I have invariably met this inquiry with the statement that the principal object of this Connecticut society is to meet together once or twice or more times during each year and have a good dinner and become acquainted with each other, and this reply in every case has seemed to give the most satisfaction, and I believe will secure the endorsement and approval of a great many men who are not now members of the Association.

So far as our affairs are concerned, it seems to me that we begin the year 1900 with brighter prospects than ever before. Our membership has increased from 100 active members one year ago to 164 active members today, including those who have been admitted at this meeting. This increase in numbers does not represent the actual value to the Association of the additions to membership which have lately been made, as several of the members admitted today include men of great prominence in engineering matters in this State, and it is no reflection on the older members to say that one of our new members probably occupies the highest and most important purely engineering position in the State of Connecticut today. This shows that we are beginning to be recognized as an Association and to take our place where we properly belong: as the official organization of our profession in Connecticut.

An effort has been made to increase our membership in the southern part of the State, especially in New Haven and Fairfield County. At the beginning of this year we had on our rolls but one active member in New Haven, a city with probably one hundred men eligible to membership, but that one man has been at work in our interest and today we have elected 18 members from the city of New Haven, largely due to his individual efforts. If each of the new members can make equally good showing one year from today, our organization will begin to assume the character of a State organization, which its charter contemplated.

If a local character has been impressed upon the Association by having most of its meetings held at and officers elected from Hartford and vicinity, it is not due to any such intention on the part of the Association, but because a more active interest has been taken in these matters and a greater number of members elected from the vicinity of this city. It is to be hoped that the membership will be increased in all parts of the State so that the officers and management of the Association will be so general in its character as to avoid any criticism on the score of locality.

We were organized in Bridgeport in 1884, and in that city we have today on our rolls four active members, two of whom were charter members, and one elected in 1885, the year following our organization. You can see that our growth here has been most unfortunate in point of numbers and, while we highly prize the loyalty and encouragement of these, our original charter members, we do need and ought to receive the support of the engineering profession in general in the city of Bridgeport, and our membership should be largely increased during the coming year.

The Treasurer's report shows the finances of the Association to be in a healthy condition. We had on hand January 10th, 1899, cash, $437.25; January 9th, 1900, cash, $620.93; which shows a gain of $183.68 in the year, which is very encouraging and gives an opportunity to improve our affairs by the use of a little more money in some lines, and I wish to suggest that after the Constitution and By-Laws are revised, they be published, together with a list of members, in the form of a neat vest pocket memorandum book with a leather cover, nicely gotten up, to send with the compliments of any member to any prospective members or friends or exchanges, which may seem advisable to him. I have had a number of calls for copies of the Constitution and a list of the members and at present we have nothing to send out which is creditable to the Association; in fact, we have no Constitution and list of members in one book.

In my circular letter I asked a question in regard to our professional standing as viewed by the different members of this Association. While several treated the question rather humorously, there were a number of replies which would indicate that the writer appreciated the importance of such matters and were striving for the recognition which is our due. One member very aptly states that, "We are still classed with the carpenters, masons and plumbers, and not with the lawyers and doctors." And I believe this is not very far from the truth, although, from my own limited observation, I think our standing is somewhat improved. It is slow work to convince people in general that we have well grounded claims to professional recognition, and that by education and training the engineer is a man of high professional knowledge and oftentimes has spent more years on his education than he would in either of the so-called learned professions before mentioned. But I believe we have reason to be encouraged, and especially in the larger cities the engineers are coming to be recognized as not merely men to run lines or make drawings or superintend work, but men of large experience and broad ideas, who can create and organize and carry out great undertakings and, as I said on a previous occasion, the appointment of an engineer to be the head of a department for carrying out public work instead of being the servant underneath a political head, is becoming more common, and we see the wisdom of such appointments in almost every case where they are made. I do not wish to imply anything against politics or political men, but I do think the people are becoming awakened to the fact that the carrying out of public works had better be entrusted to men who know something about such matters and leave politics out of the department of public works, both in city and State matters. Rewards for political services should be provided for in some other department.

Our profession is slowly but surely gaining the recognition which belongs to us and we shall some of us see the day when we shall fill our true place in the great stage of action and be respected and paid accordingly.

I wish to thank the members for their generous support which has been given me throughout the past year, and especially for the many very encouraging expressions which have been received by mail; and also to thank the officers and committees for the time and attention which they have given to Association matters.

It was voted that the salary of the Secretary and Treasurer be made fifty dollars per year.

On motion of Mr. H. G. Loomis, it was voted that the Secretary make a list of the past members of the Association and have it published in the report.

Mr. Bunce. This Association was formed some sixteen years ago, as a good deal of an experiment, and the constitution and by-laws were adopted for its guidance. We have lived along quite comfortably under that original document, but it seems to me that in certain matters we have outgrown the original conception of the Association as set forth in the constitution and by-laws, and that there can be improvements made in certain directions, and that we should have a revision of the constitution and by-laws of this Association. If that meets the views of the members, I move that the President appoint two active members of the Association who shall act with him in preparing such revisions and amendments to the constitution and by-laws as may appear desirable, and to take the necessary steps to bring such changes as they suggest before the Association at the proper time, as set forth in the constitution. The motion thus presented was passed and the President appointed Mr. Charles H. Bunce of Hartford and Mr. Robert A. Cairns of Waterbury as such committee.

On motion of Mr. Bunce it was voted that Mr. Edward S. Waters, the chief engineer of The Holyoke Water Power Company and Mr. Frank W. Skinner, of the editorial staff of The Engineering Record of New York, be elected as honorary members of this Association.

It was voted that the President be authorized to appoint the regular sub-committees, which have been appointed from year to year by the President, for the ensuing year.

MR. PATTON. I do not know but the matter I have to speak about comes within those committees, but I am interested in some legislation that will cause the towns to provide suitable accommodations for maps, so that people can record maps, and amend the law in relation to recording maps or filing them. What I would wish is to have a committee appointed to frame some amendment to section 81 of the General Statutes, relating to the filing of maps, and submit it to the Association on or before the summer meeting, so it can be presented to the Legislature at the next session. I move that such a committee be appointed, if it does not come under those committees to be appointed by the President.

MR. BUNCE. Would not that committee come under the general committee of law and legislation?

THE PRESIDENT. I do not know, but I think it would be just as well to have a special committee for that special duty.

The motion as presented was passed, and the President appointed as such committee Mr. Adrian R. Wadsworth of Farmington, Mr. Arthur J. Patton of Waterbury, and Mr. Albert L. Washburn of Hartford.

At 1.30 the meeting adjourned to the Allyn House for dinner.

A special dining-room had been arranged, where the members did ample justice to the fine menu which had been prepared, and listened to the following papers and addresses:

"Concrete Dam at Tariffville, Conn., for the Hartford Electric Light Co." (Illustrated with the Stereopticon), by Prof. William Lispenard Robb.

"The Physical and Heat Treatment of Structural Steel," by Henry Souther.

"The Co-operation of Architects and Engineers," by George B. Rogers.

"A Description of the Providence Improved Sewerage System" (Illustrated with the Stereopticon), by Herbert M. Knight.

"The Springside Sewage Disposal Plant, at New Haven, Conn.," by Henry J. Kellogg.

The meeting then adjourned.

The following members and guests were present: E. P. Auger, Middletown; A. B. Alderson, West Hartford; Henry W. Ayres, Hartford; Roswell Atkins, Bristol; Charles E. Beach, Edmund Brown, Norfolk; Charles H. Bunce, Hartford; L. W. Burt, Hartford; Edward W. Bush, Hartford; William H. Cadwell, New Britain; William B. Cochrane, Stamford; George K. Crandall, New London; L. E. Daboll, New London; Frederick DePeyster, Portland; James H. Edwards, East Berlin; Frederick L. Ford, Hartford; Christopher L. Gallup, Hartford; Edwin D. Graves, Hartford; William E. Johnson, West Hartford; Henry J. Kellogg, New Haven; Hiram G. Loomis, Hartford; George E. Manning, New London; John T. McKnight, Rockville; Shepard B. Palmer, Norwich; Arthur J. Patton, Waterbury; Ermon M. Peck, West Hartford; Halbert G. Robinson, Hartford; Henry Souther, Hartford; Clarence B. Vorce, Hartford; Adrian R. Wadsworth, Farmington; Albert L. Washburn, Hartford; John P. Murphy, Hartford; Herbert C. Keith, New Haven; Prof. William Lispenard Robb, Hartford; Harry C. Collins, Springfield, Mass.; Henry L. Norton, Springfield, Mass.; John K. Punderford, New Haven; Charles W. Eddy, Simsbury; Edward Noble, J. S. Chase, Clarence Blakeslee, New Haven; Herbert M. Knight, Norwich; Homer A. Scholze, New London; and M. N. Baker, Associate Editor of the Engineering News, New York.

The President has appointed the following special committees for the ensuing year:

FIELD WORK.

George W. F. Gillette, Chairman	New Haven
Roscoe N. Clark	Hartford
Charles W. Eddy	Simsbury

SEWERAGE.

Frederick L. Ford, Chairman	Hartford
Herbert M. Knight	Norwich
J. Frederick Jackson	New Haven

ELECTRIC RAILROADS.

John K. Punderford, Chairman	New Haven
Julius L. Adams	South Manchester
T. C. B. Snell	Hartford

ELECTRICAL IMPROVEMENTS.

Prof. Wm. Lispenard Robb, Chairman	Hartford
Harry A. Storrs	New London
Frederick P. Lewis	New Haven

LAW.

Adrian R. Wadsworth, Chairman	Farmington
Charles M. Jarvis	East Berlin
Charles H. Bunce	Hartford

BRIDGES AND STEEL CONSTRUCTION.

Arthur L. Davis, Chairman	East Berlin
William Harley Moore	New Haven
Harry C. Collins	Springfield, Mass.

HIGHWAY CONSTRUCTION.

E. P. Augur, Chairman	Middletown
Frank N. Hoyt	Hartford
John T. McKnight	Rockville
Clarence Blakeslee	New Haven
Hugh B. Tabor	Middletown
Halsey A. Weaver	Woodstock
L. E. Daboll	New London
William B. Cochrane	Stamford
Robert S. Hurlbut	West Winsted

STREET PAVEMENTS.

Frank A. Maloney, Chairman	New Haven
Christopher M. Gallup	Hartford
R. A. Cairns	Waterbury
George K. Crandall	New London
Edward T. Ward	Bridgeport
Paul Nash	Stamford

WATER SUPPLY.

George H. Bishop, Chairman	Middletown
Ely M. T. Ryder	New Haven
George E. Manning	New London
William E. Johnson	Hartford
Charles E. Chandler	Norwich
William B. Palmer	Bridgeport
Nelson J. Welton	Waterbury
William S. Clark	Meriden
William H. Cadwell	New Britain
John T. McKnight	Rockville
D. S. Brinsmade	Derby
William B. Cochrane	Stamford
A. R. Wadsworth	Farmington
C. Henry Olmsted	East Hartford
Robert S. Hurlbut	West Winsted

INSIGNIA.

Clarles H. Bunce, Chairman	Hartford
Prof. Samuel E. Barney	New Haven
A. B. Alderson	West Hartford

[illegible]

William [illegible], Chairman	Waterbury
Charles [illegible]	Hartford
[illegible]	Hartford

[illegible]

Charles [illegible], Chairman	New Haven
William [illegible]	New Haven
Charles [illegible]	Hartford

[illegible]

Theodore [illegible], Chairman	Hartford
[illegible]	New Haven
Henry [illegible]	Hartford

REPORT OF COMMITTEE ON FIELD WORK.

HARTFORD, CONN., January, 1900.

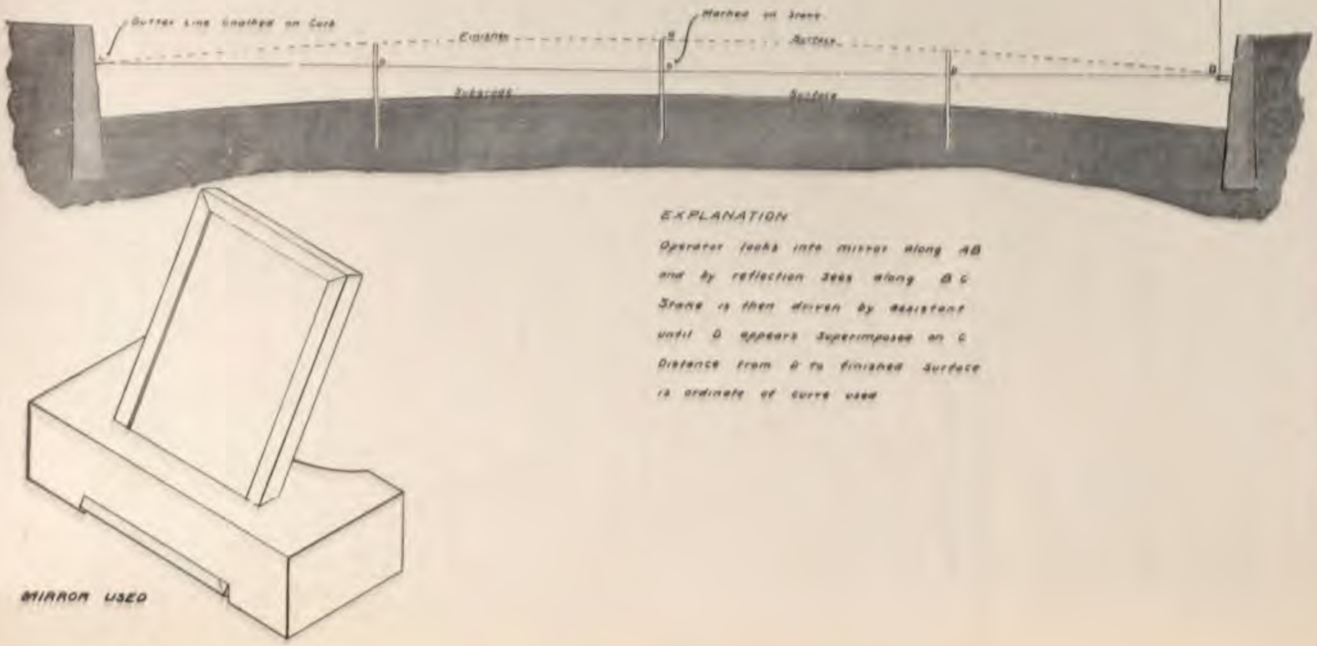
To the President and Members of the Connecticut Civil Engineers and Surveyors Association:

In accordance with the request of the President, made February 25, 1899, this committee has endeavored to obtain information of all field work performed in the State during the year 1899.

Upon receipt of the request, the committee at once divided the State into three equal portions, and assigned one to each member with the understanding that each member should take care of his particular section. This committee respectfully report, that they have sent out 40 circulars and have received replies from 14. The data obtained will hardly serve as a record of the work done throughout the State, or even of the work of individual towns, yet the committee do not feel justified in withholding what they have received, nor do they feel that it would be proper to mention individual offices. Therefore, they have concluded to give the record of each town as they have received it, trusting that the matter will thus be brought to the attention of the members, and that a proper pride in their town will induce them to give the subject more attention another year.

In view of the fact that many replies have contained matter which was not within the province of this committee, but which would have been useful if it had been sent to the President or to the proper committee, we would respectfully recommend, that near the close of each year, a printed circular shall be sent to each member, such circular to contain in detail, a list of the subjects upon which information is desired, together with a list of members of the various committees, and a definite statement of each class of work as it is divided among the several committees, so

METHOD EMPLOYED
in Staking Subgrade for Improved Pavement
in City Engineer's Office
HARTFORD CONN



EXPLANATION

Operator looks into mirror along AB
and by reflection sees along B C
Stake is then driven by assistant
until D appears superimposed on C
Distance from D to finished surface
is ordinate of curve used

that each member will know exactly what is wanted and where to send it.

It was our original intention to go a little beyond the instructions of the President, and ask for anything new or novel in the manner of performing "field work," but owing to the neglect of the chairman until it was too late, we have received only one method.

This is one of such marked excellence, that the said chairman is filled with contrition for his want of enterprise, and this committee earnestly recommend that the new committee on field work start early in the year to gather the class of field work and that members who have such will send it without being asked.

The sketch which is self-explanatory, shows the method employed by the Hartford City Engineer's office in setting stakes for paving. The term "field work" as understood by this committee, applies solely to surveys, either preparatory to or during the process of construction, and they have not considered the amount of money expended for or the amount of work done by others than engineers or surveyors during the process of construction, as coming within the scope of their inquiries.

The facts resulting from their circulars are as follows:

HARTFORD—Four Offices:

Surveys for or of streets	9	Miles
Profiles for or of streets	12	Miles
Curb lines and grades	10½	Miles
Sewer lines and grades	5¾	Miles
Surveys for macadam roads	2¾	Miles
Surveys for street railways	0¾	Miles
Surveys for steam railroads	11	Miles
Surveys for subdivision	600	Acres
Buildings staked	41	
Building lots staked	883	
Monuments set	77	

NEW HAVEN:

One office reported considerable work in dollars, but nothing that we could use.

WALLINGFORD—One Office:

Surveys for streets	2¼	Miles
Surveys for water pipe	0¼	Miles
Surveys for subdivision	27	Acres
Contour surveys	1½	Acres
Building lots staked	307	
Buildings staked	2	

BRISTOL—One Office:

Surveys for macadam roads	2	Miles
Surveys for sewers	900	Feet
Curb line and grades	6000	Feet
Surveys for subdivision	23	Acres
Surveys of farms	76	Acres
Building lots staked	20	

NEW LONDON—One Office:

Line and grade for sewers	9275	Feet
Surveys for sewer assessment	4480	Feet

MIDDLETOWN—Two Offices.

Contour surveys for storage reservoirs	50	Acres
Surveys for dams	Several	
Surveys for river improvement	No Distance	
Surveys of old highway	No Distance	
Surveys for steam railroads	1½	Miles
Surveys for macadam roads	3	Miles
Surveys for buildings	30	

WATERBURY—One Office.

Contour surveys	16	Acres
Surveys of small properties	32	Acres
Surveys of manufacturing plant	20	Acres
Surveys for subdivision	208	Acres
Lots staked on above	169	
Old lots surveyed	175	
Streets laid out	4.8	Miles
Profiles of streets	3	Miles
Monuments set	98	

Respectfully submitted,

A. J. PATTON,
F. L. FORD,
Committee on Field Work.

SEWERS.

The Committee on Sewerage made no report, but the following data has been compiled:

Meriden—13,735 feet by day labor, at a cost of $1.70 per lineal foot. The filtration disposal beds, fourteen in number, worked very satisfactorily, and no complaints of any nature were made during the year.

East Hartford—Plans and surveys for a complete sewer system.

West Hartford—Surveys have been made for sewering West Hartford Center and the Charter Oak districts.

New Haven—3372 feet of brick sewer and 6263 feet of tile sewer were constructed during the year.

Hartford—12,089 lineal feet of sewers, 6″ tile to 42″ double ring brick; total cost $25,081.

Waterbury—2 miles of 8″ to 15″ tile, costing $18,000.

New London—9,400 feet of 6″ to 18″ tile sewers, constructed by day labor at a cost of $10,500. 8300 feet of 8″ to 24″ tile constructed by contract at a cost of $10,030. A 24″ wooden submerged outfall, extending out 720 feet from the shore, was constructed under contract for $4279.

Greenwich—Two miles of sanitary sewers at a cost of about $12,000.

South Manchester has prepared sewage disposal beds, 6 beds, 1 acre each.

New Britain—Surveys and plans for sewage disposal.

REPORT OF COMMITTEE ON RAILROADS.

I have sent out circulars to most of our members, and to others likely to have the information we want, and have received about twenty replies. The accompanying letter from William G. Smith contains an account of his important project in New York State, the construction of third rail electric railway, 35 miles in length, from Albany to Hudson, which, with reservoir for water power and the gear required for running the road costs the notable sum of $2,200,000.

From the report of the Railroad Commissioners for the year ending June 30, the following interesting items may be mentioned: Steam railroads, number miles main line and branches, 1,013, and of single tracks, including sidings in the State, 1,819; increase for the year, 14 miles; whole number of miles of the several railroads, 2,330. Whole number of passengers carried, 50,269,468, of whom only eight were injured, none killed; a good showing for safety of steam railroad travel. Number of employes, 28,211, of whom 185 were injured, inclusive of 29 killed. Number of track walkers injured, 117, and of this number 71 were killed. Number of grade highway crossings in the State, 998, nine less than a year ago. Number of highway crossings passing under the track is 258, and of those passing over the track is 223. Under the safety appliance act of Congress, March 2, 1893, requiring all engines and cars moving interstate traffic to be fitted with automatic couplers and power brakes, it is interesting to note that in June of the past year there remained only 211,268 freight cars out of 2,268,000 still unequipped, and that the great Consolidated road of this State has at this present date no cars unprovided with the safety appliances. Mileage of all the passenger trains, 13,836,683, in the 2,330 miles operated, which would indicate about six millions as the mileage of said trains for the State, there being, as above noted, 1,013 miles of line in Connecticut. If the same ratio, .435, remains good for the number of passengers carried during the year in the State, we may conclude the number to be about twenty-two millions. F. S. Curtis, chief engineer of the N. Y., N. H. & H. R. R. Co., states in a letter to me, that they "have made no new locations of line during the year, either in Connecticut or on any other part of the road."

The third rail improvement by the Consolidated road has been extended to Bristol.

Work has begun on the elimination of grade crossings in the city of Bridgeport, authorized by special act of the Legislature in 1895, and which has been delayed by litigation. This important project looking to the safety of that community, provides for the raising of the tracks over the streets, and may be expected to be prosecuted with vigor and expedition. On December 8th ult., the Railroad Commissioners issued orders for the temporary closing of the adjacent streets so far as they may be required for railroad use in executing the improvement.

The plans for the improvement through this city provide for elevating the tracks. This will be done on masonry viaduct, with proper openings, spanned by steel bridges, for the different streets, except along the water front, where the elevated structure is to be of open steel construction, and across the river, which is to be spanned by a four-track steel drawbridge. The plans also provide for a new passenger station.

Mr. Chandler reports that the "New Haven road has put in new track, and largely new road bed, from Norwich to Allyn's Point, and built an entirely new and exceedingly expensive road from Allyn's Point to New London" (Groton). "Some $600,000 of bonds are being issued to pay for it." Length of this extension 5.10 miles. Sidings in total length of 8.9 miles have been built the past year.

The construction of the Tariffville branch of the H. & C. W. R. R., extending from Tariffville to a connection with B. & A. R. R., near the city of Springfield, was commenced Jan. 28, 1899, and is now completed, and the track laid, except a few hundred feet in the town of Granby, across a certain piece of land which the H. & C. W. R. R., not being able to procure by purchase, is now seeking to condemn, pending which proceedings in the Superior Court certain legal questions have arisen, which are likely to be carried to the Supreme Court for determination."

This branch is 14.4 miles in length and cost $450,000.

Among the notable improvements of the year by the N. Y., N. H. & H. R. R. Co. may be mentioned the retracking of the entire New London division and the Stonington division with new steel rails, weighing 100 pounds to the yard.

On the Central New England Railroad three bridges and two trestles were replaced with steel structures at a cost of $18,000.

A new station erected at Norfolk at cost of $7000.

The New York, New Haven & Hartford Railroad Company have also had the following work during the past year:

Bristol—The elimination of the grade crossing of Main street with the Highland Division, by depressing the highway and taking it underneath the tracks, is now under way.

Newington—The change of the crossing of "Wethersfield road," located about a mile and a half south of Newington station, from grade to over the tracks of the Hartford Division, is also in progress.

East Hampton—A change is being made in the structure over the highway east of the station, Air Line Division, that is, renewing the iron structure, giving additional width of roadway for the highway underneath and reconstructing the substructure for double track.

Willimantic—Rebuilding the bridge over the Willimantic River on the Air Line Division with two spans steel bridge in place of the present through structure.

STREET RAILWAY.

The length of line and sidings, June 30th, was 443 miles, about and some 35 miles have been built the past year; about 60,000,000 passengers have been carried, and for the year ending with the date above written, 324 persons were injured, of whom twelve were killed. In the sad catastrophe of August 6th, on the Shelton Street Railway, 29 persons were instantly killed and six injured.

The commentary is, safe and solid construction of bridges and trestles, guard timbers, guard rails, less dare-devil speed, and eternal vigilance.

As to the value of fenders, there seems to be little confidence in them as at present constructed and used. As far as heard from, dogs seem to be the chief beneficiaries.

Norwich—Mr. Chandler reports that the Norwich Street Railway system has been extended about ¾ miles the past year; T rail, weight 50 pounds, in block pavement, 90 pounds girder rail, and that "work on the Norwich and New London trolley road (Montville Street Railway) has been going on all the year. Track has been laid about half the way, beginning at Norwich." Much rock cutting and deep filling has been done, and grades in highway used which ran up as high as 12 per cent., have been reduced to conform to their maximum standard of 7. Commendable care in the management of the Norwich Street Railway is shown by the fact that "only one person has been killed in the history of their electric road," and that their maximum speed is 8 miles to the hour.

Mr. Cadwell reports for Plainville and Southington that preliminary survey for about 12 miles of electric road has been made during the year, and that 4 miles have been built, at expense of about $10,000 per mile for construction. The T rail is used, weight 60 pounds per yard. This line connects the Connecticut Power and Lighting Co. lines, and the Meriden, Southington, and Compounce Tramway. Length of line in operation in towns of Berlin, Newington, New Britain and Plainville about 26 miles. Number of passengers carried, 2,078,275; one killed and five injured. Speed from 6 to 30 miles per hour.

Mr. Kellogg reports that the New Haven lines are about 70 miles in length, T rail of 70 pounds, speed 10 to 12 miles, with only one passenger killed; fenders useful in a few instances.

Mr. Bacon reports length of line in Danbury 11 miles, passengers carried 1,132,032, none killed, none injured, speed 8 miles.

The People's Tramway Co., extending through Danielson and Dayville to Putnam, has, it is understood, trackage rights for ·out 30 miles from Moosup to the Massachusetts State line;

ten miles of the projected lines are already in operation and five miles under construction.

Among the prospective extensions of trolley lines may be mentioned the line from Bristol to Terryville.

S. C. PIERSON.

WATERBURY, CONN., Dec. 29, 1899.

Mr. S. C. Pierson, Civil Engineer, Meriden, Conn:

Dear Sir:—In reply to your circular letter of enquiry, I have for the past year been engaged on the construction of a third rail electric railway running from Albany to Hudson, N. Y., 35 miles. The third rail will be laid outside of the main track rails. The road is on a private right-of-way throughout. The steel bridges will cost $125,000, and include a viaduct, 2,100 feet long, crossing over the B. & A. R. R. and the N. Y. C. & H. R. R., in Rensselaer. The rails weigh 80 pounds per yard, of "T" pattern. The joints are bonded with 0000 concealed copper bond. The rails are connected by continuous joints. The cross ties are laid 2,640 to the mile. In connection with the construction of the road, a power house is also under way containing about 7500 horse power of machinery; it is expected to generate electricity by water. For this purpose a new stone dam has been constructed with appurtenances, from which two steel pen-stocks, each 7½ feet in diameter, are laid to the power house ½ mile. Each penstock has a stand pipe at lowest end, 100 feet in height and of same diameter. The effective head of water at the wheels is 104 feet. The water shed above the dam is 350 square miles. In addition, there will be constructed a storage reservoir covering 720 acres, 2¾ miles in length, and containing 8,500 million gallons. The dam will be of earth, with rubble core wall, and 67 feet in depth at the waste gates. Dam and reservoir site will cost about $110,000. The electric current will be alternating, as sent out from the station, at a voltage of 13,000. Sub-stations will be located at each end of the line, where the current will be transformed into direct current and fed to third rail at a voltage of about 600.

The whole scheme will cost about $2,200,000.

Yours truly, WM. G. SMITH.

REPORT OF THE COMMITTEE ON ROADS AND ROAD MAKING.

To the Connecticut Civil Engineers and Surveyors Association :

Subsequent to the appointment by the President of the three members of this committee, at their suggestion, several other members were added. The committee as enlarged consisted of the following persons: Charles E. Chandler of Norwich, E. P. Augur of Middletown, L. W. Burt of Hartford, L. E. Daboll of New London, Huber D. Card of Willimantic, William H. Cadwell of New Britain, D. S. Brinsmade of Birmingham, W. L. Clark of Meriden, H. J. Kellogg of New Haven, F. W. LaForge of Waterbury, William B. Palmer of Bridgeport, William B. Cochrane of Stamford, Robert S .Hurlburt of Winsted and John T. McKnight of Rockville.

On Tuesday, March 21st, 1899, a meeting of this committee was held at the rooms of the Hartford Club in Hartford, the members of the committee and others present being the guests of the President of the Association, Mr. Edwin D. Graves. After discussing the subject of roads and pavements somewhat informally, and outlining a plan of work for the year, an elaborate lunch was served. Such statistics as we have been able to obtain by personal solicitation, and from city reports at hand, are given in a table appended to this report. For an excellent presentation of the subject of pavements with some useful and reliable data, concerning the cost of the same, reference is made to a paper on The Paving Question by Mr. S. C. Pierson of Meriden, Conn., given at the annual meeting of this Association in 1897, and printed in the report for that year.

The number of miles of State improved highway completed during the years 1896 and 1897, and the average cost per mile, also the number of miles of such roads completed during 1898, as given by the State Highway Commissioner, are given in the table of this report. None of the sections of State highways begun in 1899 are yet accepted as completed, consequently no official information concerning the same can be given at present. The table probably does not include all of the more permanent and expensive forms of pavement laid in this State. Certainly it does not embrace all of the telford and macadam roads constructed. It covers only such pavements of any of the classes given as have in some way come to the knowledge of the members of this committee.

We propose in this report to give some of the opinions and suggestions of the various members of the committee and others concerning the better kinds of pavements and also concerning telford and macadam roads, for the construction of which, on country roads large amounts are being annually expended in this State.

Of the more expensive and durable forms of pavement now in use in this State, sheet asphalt or block asphalt, on a good concrete foundation, must be regarded, from opinions expressed by engineers, under whose direction the same have been laid, as having the first and second places as to practical merit. As to which should stand first, opinions differ, and differing circumstances have much weight in determining. The city of Hartford, having both kinds in use, seems to give the preference to sheet asphalt for most of the streets on which one kind or the other has been placed. In Hartford and Meriden, Trinidad Pitch Lake asphalt has been used for sheet asphalt pavements, and has given good satisfaction. In New Haven, Sicilian Rock asphalt has been used, and the city engineers state that there is some objection to their sheet asphalt pavements, as being slippery. Hartford, New Britain and Stamford each have block asphalt pavement in use, which gives good satisfaction, and which, where that kind only has been tried, is considered the very best. Next in order of excellence, probably, are the brick pavements, of which Hartford, New Haven, Meriden, Waterbury, Norwalk, South Norwalk and Stamford each has laid a larger or smaller amount on concrete foundations of from 4" to 6" thickness. These pavements seem to have been generally satisfactory, though the edges of bricks in some cases have chipped off considerably more than was anticipated. One engineer, where such pavement has been laid, is of the opinion that some form of vitrified block will yet be devised which will be superior to the bricks now used. Hartford has covered its brick pavement laid in 1892 with sheet asphalt during the past year.

Little need be said of granite block pavements, which are more costly when of first-class blocks and construction than any of the above mentioned pavements, so far as our table shows. The relative merits and defects of granite block pavements are too well known to need special mention. In cities of over 25,000 of population, on the streets of most and heaviest traffic, in the interests of good economy and of the best possible sanitary condition of the roadway itself, the opinion has been expressed that some one of the more perfect kinds of pavement should be adopted, in preference to either telford or macadam. But for streets of lighter traffic in smaller cities, and for the more important highways in the country towns, telford and macadam are still the best kinds of road surface. If Telford and McAdam, and the followers of these famous road builders of two or three generations ago, differed as to the relative merits and advantages of the two kinds of broken stone road surface, it is not strange that engineers of the present day should not agree as to the relative merits of each. Some believe that a telford road, though somewhat more costly at the outset, is more durable and more economical than a macadam road. If the telford bottom course is properly laid, there will be no subsequent loss of the more expensive crushed stone, except by being worn out by travel. The good foundation will remain unimpaired.

A criticism appears in one of the replies received, concerning the macadam roads built under the State Highway Commissioner's specification, which seems to the writer to be a just one, namely, that it is not good policy to cover the surfaces of highways with a "veneering" of crushed stone. If McAdam were here today, he would refuse to own as of his kind some of the roads which bear his name. There is a distinction between a pavement of crushed stone and a surface hardening of the same material, and the line between the two is doubtless often drawn at too litttle depth of broken stone. Opinions also seem to differ as to whether sand or some other kind of earth or loam should be used as a filler and binder for broken stone roads, either for the whole depth of the stone, or near the surface. Sand or earth is rigidly excluded in the construction of the State improved highways. It might not be wise or safe for the Highway Commissioner to allow any sand or earth whatever to be used with the crushed stone, even if he believed more or less of such material of the right kind might be of real benefit to the road, owing to the probability that if allowed at all, too much earth, or very unsuitable earth would be used. No censure or criticism is directed at the Commissioner for the stand he takes regarding the use of sand or earth on State highways. It has been noticed, however, that some of the roads finished with only screenings of hard trap rock, and accepted as all right, have soon shown many loose stones of the larger sizes on the surface, which have had to be removed with a rake or otherwise. In some cases a light dressing of gravelly earth or coarse sand applied along the middle of such a road has soon effected a smooth and well bonded surface. In one reply, such treatment of broken stone road surface from time to time is recommended, as tending to increase the durability of the good, even surface of the roadway, particularly if liable to become too dry, and to need sprinkling, which might be impracticable. Our informant thinks the layer of clean, coarse sand, or fine gravel, should never exceed one-half an inch in thickness, and should be applied upon the middle half only of the roadway.

On one of the best constructed macadam roads built in this State during the past year, on the Hartford avenue approach to the bridge across the Connecticut River at Hartford, a sand cushion three inches deep was laid, upon which ten inches in depth of crushed stone was applied in two layers filled with sand from the bottom, except for the upper two inches, in which screenings were used, all having been well compacted with a steam roller.

It seems to be considered advisable to use gravel in preference

S OF CONNECTICUT.

SURVEYORS ASSOCIATION.

TELFORD.			MACADAM.	
Sq. Yds.	Cost Per Sq. Yd.	Year.	Sq.Yds.	Cost Per Sq. Yd.
......	......	......	......	......
......	......	......	......	......
......	......	......	......	......
......	......	......	......	......
......	......	......	......	......
......	......	......	9,000	85c.
......	......	......	......	......
......	......	......	......	......
......	......	......	......	......
......	......	......	†26,078	40c. to 84c.
......	......	......	......	......
......	......	......	......	......
......	......	......	14,249 22,500	by town by city
......	......	......	......	......
......	......	......	......	......

given by the other members of

to crushed stone where good, clean, medium coarse gravel is abundant and available at moderate cost, and where crushed stone might be too expensive.

The prevalent opinion seems to be that in localities where granite only is found and of a kind much inferior to trap rock for a surface material, the native stone may be used to advantage for the lower part of the depth, but that trap rock or some other stone of durable quality for surface material should be used for the upper two inches of the road.

The opinion has been expressed that, under present circumstances and conditions, engineers are often greatly at a disadvantage in their relations to the State improved highway construction. In the first place, they are often brought into competition with men of considerably inferior qualifications and equipment for such work. In many towns the selectmen solicit proposals for the engineering work for such improvements, and are quite ready to employ the lowest bidder, regardless of qualifications. Good engineers sometimes offer their services at a price which will oblige them to do the least possible amount of work on surveys, plans and location, or, to do the work, if properly done, at considerably less than a fair and adequate compensation for the amount and kind of service rendered. There is sometimes another disadvantage in having no supervision of the work after grades and lines are given, with some one to interpret the same to the contractor, who does not appreciate how closely the grading, etc., ought to conform to the grades given. Thus it sometimes happens that the engineer himself is ashamed of the results of his efforts. In all that has been stated, there has been no thought or intention of reflecting any discredit upon the State Highway Commissioner or of implying any blame or responsibility on his part for any of the unfavorable conditions of which mention has been made. He, too, doubtless has trials of his own, and often finds things which he wishes were different, and conditions which must be cheerfully borne until improvement is possible.

We desire, in closing, to acknowledge the assistance which has been given by the other members of the committee, and by city engineers and others in kindly and promptly furnishing facts and other material for this report.

In behalf of the committee,

E. P. AUGUR, Secretary.

Middletown, Conn., Jan. 8th, 1900.

ADDITIONAL DATA OBTAINED FROM MEMBERS OF THE ASSOCIATION.

Meriden—On twelve streets, aggregating 43,659 square yards, there was given a light or heavy macadam treatment, as the exigency of the case demanded. The work was well compacted with roller; average cost, 8½ cents per yard.

West Hartford—About 25 miles of street lines have been run out, and 130 granite merestones set.

Hartford—Grades were given on 43,502 feet of curb; on 37,952 feet of sidewalk, and on 36,917 feet of street grading.

Waterbury—5,000 square yards of macadam at 75c. per yard; 600 feet of brick and concrete channel. Cost, $10,000.

Street grading, retaining walls and other work, $22,000.

4,200 feet gravel road, cost $3,276, 20 feet wide, 14 inches deep.

New London—Granite block paving laid on sand foundation, 5,000 square yards at $1.44½; 2,200 square yards at $1.49.

About one-half mile of macadam, 6 inches deep and 25 feet wide, cost $1.74 per lineal foot.

REPORT OF THE COMMITTEE ON MASONRY.

A detailed account of the masonry construction in this State during the past year will no doubt be furnished to the President by the various engineers who have had charge of the work, and a recapitulation in this report does not seem to be necessary. Two special pieces of masonry have been called to the attention of many members of the society, which we think may reasonably be made special mention of. The first is the great dam at Holyoke, Mass., which has only just been completed. All of the exposed portions of this work are of granite and may certainly be considered a specimen of the refinement of masonry construction. Every stone was cut to a template at the quarries and brought on to the work ready to be set in place, and so carefully was this work done that only the closures in each course required any cutting on the ground. This is a fine example of first-class work demanded by a corporation who were able and willing to pay for such work.

The second piece of work is connected with the construction of the highway bridge in East Hartford, which has several points worthy of consideration. This consists of the abutements and piers of stone from the Portland Brown stone quarries. All the stones in the piers and in the faces of the abutments were cut at the quarry and delivered on the work ready for setting. The piers were constructed with two lines of stretchers and every header a through stone, necessitating no filling and making a consequent great saving in masonry. The abutments were laid up with cut stone faces, and the backing, instead of the usual method of using rough stone, was filled in with concrete. This was thoroughly good construction and resulted in a great saving of time, which was a very important factor on this job.

The first is an example of almost lavish expenditure of money to accomplish a great work.

The second is a fine illustration of economy of construction without sacrifice of stability.

Respectfully submitted, C. H. BUNCE,
FRED'K DE PEYSTER,
J. T. McKNIGHT,
Committee.

REPORT OF THE COMMITTEE ON LAW.

To E. D. Graves, President:

Dear Sir:—The committee on legislation beg leave to report that the most important legislation of the General Assembly of 1899, affecting the interests and claiming the attention of the members of this Association, were the "Acts" creating the Sewage Commission and the Highway Commission.

The Sewage Commission consists of five persons, appointed by the Governor, with terms of office running four years, from June, 1, 1899, with a salary of one thousand dollars each and actual expenses. The purpose and duties of the commission are to continue the investigation already begun by its predecessors of the various methods of sewage purification, and construction of sewage plants or disposal works, in this country or others, and with a view to protecting the public health, the commission is authorized to employ an expert bacteriologist to determine the character of the pollution in the waters of the State receiving the discharge from the various effluents of its sewers.

Any town, city or borough may consult the commission and obtain its advice concerning sewerage systems, methods of sewage disposal and operation relating thereto by payment of expenses incurred by any special investigation on the part of the commission. The commission must formulate and submit the results of its investigations to the next General Assembly.

From the foregoing, it can be seen that the commission is simply advisory in its functions, seeking by investigation and research to intelligently direct public opinion upon a question which rises into greater prominence with each recurring year, due to the limitation of the streams to bear the increased burden of pollution imposed upon them by a rapidly increasing population. The creation of the commission was in recognition of a popular demand for a speedy relief from a situation which menaces the health and good feeling of every riparian community in the State.

The high character of the present members constituting the commission give promise that great advancement will be made on the question of sewage disposal. The members are ex-Gov. Lorrin A. Cook of Winsted, Dr. E. H. Jenkins of New Haven, R. A. Cairns, C. E. of Waterbury, Dr. John N. Woodford of Sherman, Frank R. Gallaher of Essex.

The commission having determined the preliminary steps for the most satisfactory and economical disposal of sewage, and advising general and uniform laws in accordance therewith, should be invested with powers of general supervision over the sewerage systems of the State, being constituted into a permanent commission having general powers of approval and negation as far as new systems of sewerage are concerned, and should be clothed with authority to require from the localities which now have sewerage systems such measures as will prevent further injury to the streams of the State and the owners of property on their banks.

It is useless to assure those who have a personal knowledge of existing conditions and surroundings that the subject is one of the greatest importance, and demands speedy and effective action from some properly constituted authority.

Upon its proper solution depends not only the present comfort and health, but the future growth and prosperity of the people of the State.

The present Highway Commission, as established under the statutes passed by the last General Assembly is a distinct gain in the interest of good roads, in that it carries an increased appropriation of two hundred thousand dollars in excess of the previous statute, enacted two years before in 1897.

The principal feature in the present law is the increased proportion of the cost of construction to be borne by the State. In towns having a grand list of more than $1,000,000, two-thirds of the cost is paid by the State; in towns having a grand list of $1,000,000 or less, three-quarters is paid by the State.

The total appropriation was the sum of $350,000 for two years.

And again the setting aside from the total appropriation the sum of $12,000 for supervision of the work during construction, by inspectors to be appointed by the Highway Commissioner, is a new departure and a special feature of the present statute, its purpose was to secure thorough and efficient inspection during the progress of the work by capable experts working in the interests of the State. The writer is informed this inspection has been largely delegated to the selectmen of the different towns of the State, who are already paid by the several towns they serve for attending to its interests.

The good road movement stands first in its importance to our material welfare, and should receive the earnest encouragement its importance demands from the members of the Connecticut Civil Engineers and Surveyors' Association.

Respectfully submitted,

A. R. WADSWORTH, Chairman.

REPORT COMMITTEE ON WATER SUPPLY.

To the President and Officers of the Connecticut Civil Engineers and Surveyors Association :

Gentlemen :—Your committee on water supply would call your attention to the fact, that in the history of this Association the year 1899 has exceeded all previous records in the experience of water supplies, in that a larger number of the works have been obliged to obtain temporary assistance to supply their consumers than at any previous season. Hence it has necessarily become an exceedingly interesting question for investigation and particularly the duty of your committee to report on so far as they are able to do with due courtesy to the officials in charge of these particular works.

In our investigations as to the cause of this effect, we are led to the records of the elements that supply all water and find that several of the supplies have had an unusually light rain fall which has necessarily affected in like manner the flow of the streams, but fail to find any record less than 34 inches or about 71 per cent. of the normal conditions, while the government records show the average precipitation of the State from Dec. 1st, 1898, to Dec. 1st, 1899, to be 41.30, and the entire New England district 38 inches.

Consequently, while the rain fall will prove the source of a portion of the deficiency, the large portion is due to other causes. The element of evaporation could not have been unusually excessive because the water surfaces of the storage reservoirs and streams being largely drawn on were probably of much less acreage or area than under ordinary conditions.

RAINFALL OF NEW ENGLAND STATES.

	Maine.	New Hampshire.	Vermont.	Massachusetts.	Rhode Island.	Connecticut.	Entire District
December, 1898.	2.34	2.43	2.08	2.64	2.59	2.50	2.43
January, 1899	3.23	2.62	2.21	3.91	5.52	4.05	3.59
February, "	3.28	2.85	2.50	4.19	4.87	4.73	3.74
March, "	5.44	5.84	5.46	6.67	8.36	6.82	6.43
April, "	1.16	1.30	1.53	1.73	2.29	2.08	1.68
May, "	2.18	1.34	1.48	1.37	2.30	2.05	1.79
June, "	3.34	2.43	2.97	3.69	2.61	3.25	2.88
July, "	5.23	4.65	4.87	3.86	3.78	5.62	4.67
August, "	1.00	1.79	1.79	2.14	3.12	1.78	1.94
September, "	3.56	3.85	4.42	4.76	6.91	4.58	4.68
October, "	2.04	1.09	2.13	2.29	2.83	1.83	2.01
November, "	2.74	2.02	2.23	2.05	1.87	2.01	2.16
December, "							
Total	35.54	32.20	33.65	39.30	47.05	41.30	38.00

NOTE—Rainfall records for December, 1899, are not available till after January 16th, 1900.

N. B.—It will be noted by the above table that the precipitation in the State of Connecticut for the months of February, March and April was in the aggregate 15.60 inches or one-third of the annual precipitation. The average yield of the streams for those months is 52 per cent of the total annual yield.

That the months of June, July, August, September and October average yield is but 14 per cent. of the total annual. Hence large quantities probably passed over the waste ways previous to May at the various storeage reservoirs, and which, owing to the light distribution of the rainfall for the balance of the year occasioned unusual drafts on the storage capacity and beyond their ability to supply under this unequal distribution of the precipitation also excessive waste. At the Higby Mountain Reservoir in Middletown the overflow or wastage previous to and in May was by measurement nearly 300,000,000 gallons (water shed 2 miles).

By an examination of the usual consumption prevalent in this State, by the per capita comparison with other New England cities, it is readily observed that there is a vast difference in the amount of water consumed—many cities in eastern Massachusetts and Rhode Island supplying less than half the quantity per capita customary in portions of this State with apparently equal satisfaction to their consumers, while European cities are supplied with an additional reduction of fifty per cent. per capita.

Hence, it should and must be met by water commissioners and the legal voters that they represent, whether they will continue adding to and enlarging their plants or retrench on the part of their consumers. If the eastern cities can supply their inhabitants by the use of 50 to 70 gallons per day, per capita, it is idle to say that we in this State require double or more than that amount to amply supply our population or customers.

It will be but a few years when the question of purifying all water for domestic use will assuredly follow, which must be met by some process of filtration causing a large outlay.

Finally, the whole subject matter necessarily rests with the officials and the legal voters they represent, whether the engineer shall have specific instructions to enlarge each particular water supply in such a manner that it will furnish its consumers during an annual precipitation of about 32 inches (because all works should be prepared to meet such an emergency) and on such basis of 50 or 150, or more, gallons per capita, or that they will on their part enforce the principal of measuring the water to its consumers, thus reducing the consumption to a reasonable basis.

We are convinced that (in connection with the annual increase) safety demands all water supplies should be capable at all times of furnishing its full line of customers or patrons with ample quantity and under a precipitation of 32 inches annual rainfall, consequently, unless so arranged, the works are to that extent deficient, because all works are liable to meet the minimum rainfall. In other words, our water supplies have not, in several cases, proved equal to the emergency that they were called on to meet during the past season of 1899.

All of which is most respectfully submitted,

GEO. H. BISHOP, Chairman.

ADDITIONAL DATA OBTAINED FROM MEMBERS OF THE ASSOCIATION.

Meriden—During the past year the supply from the reservoirs gave out. A temporary pumping station was installed at Twiss Pond. On account of the excessive waste the water superintendent and board of public works have urgently recommended the adoption of meters. 409 feet of 4" pipe was laid, at a cost of sixty-eight cents per foot.

Middletown—Surveys have been made for four different reservoir sites for proposed additional supply for the Connecticut Hospital for the Insane.

Waterbury—Two miles of mains, 24" to 4", costing $16,000.

Watertown—Earth dam with masonry core wall and pipe system complete, at a cost of $60,000.

Hartford—Surveys have been started investigating an additional supply from the town of Granby. From October 17th, 1899, to February 9th, 1900, 3,000,000 gallons daily were pumped from the Connecticut River to help out the supply from the West Hartford reservoirs.

Farmington—The Farmington Water Company constructed a filter bed, 75 feet by 100 feet, as follows:

"The bottom of the filter bed is laid with six and four-inch tile and covered to a depth of one foot with stone, graduated in layers to the top, which supported two feet of sharp white sand. The construction of the supply pipe is so arranged that the bed can be filled from underneath, the water finding ready access to every part through the substratum of stones. When the water reaches and covers the top surface of the sand the supply will be changed from the sub-conduit to the upper conduit, which will throw the water into the air, having an aerating and oxidizing effect, tending greatly to vitalize and deodorize the effluent." Cost $1,500.

REPORT OF THE COMMITTEE ON BRIDGES.

Mr. Edwin D. Graves, President Connecticut Civil Engineers and Surveyors Association, Hartford, Conn.:

Dear Sir:—As chairman of the Committee on Bridges of the Association, I beg leave to submit to you herewith my report. In making this report it has been assumed that work under the head of bridges comprises, also, to some extent, other classes of structural steel work, as well as bridge work.

The work done in the State during the year 1899, in the way of bridges, has not been in any way unusual. The business done by The Berlin Iron Bridge Company will, perhaps, give a fair idea of the extent of the bridge work and other structural work erected in the State during the year. The business of the company for the year 1899 was remarkable. The amount of contracts taken during the year was approximately $2,000,000, and this work, of course, extended over a large amount of territory. The amount of bridge work done in the State of Connecticut during the year amounted to a trifle over one-eighth of the total amount given above, or about $260,000. This amount was divided approximately as follows:

Railroad bridges, $22,000; electric railroad bridges, $26,000; and what might be termed strictly highway bridges, $212,000.

Of course, a large amount of structural work, such as buildings, roofs, etc., was done in the State, and is not included in the above amount.

Outside of the State the work has been about evenly divided between bridge work and structural iron work in general, and has been scattered over a wide extent of the country. We have furnished material and erected one bridge at Hilo, Hawaiian Islands, and have also furnished a bridge in New Zealand. We are now erecting in Vincennes, France, for the Paris Exposition of 1900, a machine shop building, to be used exclusively by American exhibitors of machine tools.

The highway bridge work has been of the usual class, comprising town bridges which have been built of steel, in many places replacing old wooden bridges, and in some places at new sites. There has been a marked tendency to bridges of higher capacity, which is accounted for perhaps by two reasons. One reason is the fact that the road improvements which have been carried on by the State has brought into use heavy road rollers, which necessarily have to be taken over our bridges. These bring upon the bridge floor heavy concentrated loads, which have to be considered carefully in the design of the bridge. Nearly all new bridges now are built for these heavy loads, and many old ones during the year have been strengthened for the purpose of carrying the additional load of heavy road rollers. Another reason for the increase in capacity is due to the fact that many of our country and city bridges now are crossed by electric street car lines, which demand extra heavy structures of special design to carry them.

Perhaps the most interesting piece of bridge work which has been done in the State during the year is the Meadow Bridge at East Hartford, which has been built under the supervision of our President, Mr. Edwin D. Graves, engineer of the Connecticut River Bridge and Highway District. A description of this bridge has been kindly furnished by a member of the committee, Mr. Edward W. Bush, and is submitted with this report.

Of the various bridges for electric roads simply, several have been built in different parts of the State. The largest extent of work of this character no doubt was done on the line of the Shelton Street Railway Company, a line running from Bridgeport to Derby, Conn. Several spans of steel bridges were built on this line, varying from 40 feet to 130 feet in length. They were all of the full deck, plate or latticed girder type. The largest bridge is one erected at Peck's Mill, near Stratford, Conn., a bridge which has been brought into some prominence by a disaster happening near the bridge shortly after the road was opened. This bridge crosses the Peck's Mill pond, and has a total length of 655 feet. The portion of the bridge over the water is composed of four 130-foot deck latticed girder spans. The foundation of this bridge consists of piers of stone masonry built above the water level, on which are placed trestle bents of steel, carrying the girders of the bridge. The height from the top of the rail to the top of the masonry is about 27 feet. Each span consists of two trusses about 13 feet deep, placed 12 feet apart on centres. Ties carrying the rails are placed directly on the top chord of the steel trusses. The trusses are braced at both top and bottom chords, and vertical diagonal bracing between the trusses, by means of stiff angle iron connections. The approaches to the bridge on either shore of the pond are of the usual plate girder type supported on trestle bents.

There has been erected at New London in this State a structure of more than usual interest, and it occurred to the committee that it might be well to have attention brought to it in the committee's report. The structure referred to is the new coal handling plant for the United States Navy. We were fortunate to have with us at the meeting of the Association Mr. A. C. Lewerenz, civil engineer of the United States Navy, who had charge of this work during construction. Mr. Lewerenz gave a brief talk, describing the work done there, and exhibited drawings of the structure. He has furnished a report of this work, which is submitted herewith. The cuts accompany his report. Figure 1 was made from a drawing which shows the location of the coal storage building with reference to the government dock and property at New London; figure 2 gives a view of the structure as completed.

On December 23d, 1899, New Haven opened travel on the new Chapel street drawbridge over the Mill River.

"The method of construction adopted for the pier and abutments is as follows: The partial dredging of the site after the removal of the old structure, and then the driving of sheet piling so as to give the proper size and shape to the piers and abutments, after which, the balance of the material is to be dredged out inside the coffer dams to the hard bottom, which is at an average depth of about thirty-six feet below mean high water.

"The sheet piling is to be made tight enough to exclude the mud and make the water inside the coffer dams absolutely quiet. The concrete is then lowered through the water in a tight iron box holding one cubic yard, and, as soon as it comes in contact with the bottom, the box opens automatically at the bottom, and it is then carefully raised for the first few feet, and, in this manner, the concrete is left in place with very little disturbance. This concrete is carried up to a point two feet below low water, where the stone masonry is to begin, thus forming a body of concrete twenty-eight feet deep and forming, when set, one solid monolith. The coffer dam above this point is then made tight enough so that at low water the remaining two feet may be pumped out and the water kept down while the first course of stone is laid.

"This work of depositing the concrete has been completed for the pivot pier and with complete success.

"The loss of cement from the concrete in the work of depositing, was not perceptible, and, when the water was pumped out, about ten days after the completion of the work, the concrete was found to be as hard as a rock.

"The dimensions of the bridge will be as follows:

"Length from center to center of end pins, 220 feet; width from center to center of sidewalk railings, 51 feet; width of roadway between wheel guards, 33 feet.

"The roadway will be paved with vitrified brick.

"The bridge will be operated by electricity."

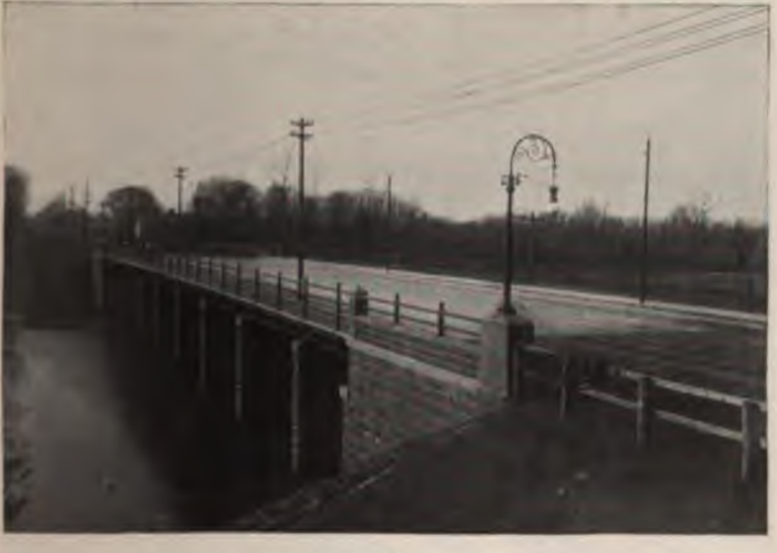
JAMES H. EDWARDS,
Chairman Committee on Bridges.

BRIEF DESCRIPTION OF THE MEADOW BRIDGE, EAST HARTFORD, CONNECTICUT.

Connecticut River Bridge and Highway District.

BY EDWARD W. BUSH, ASSISTANT ENGINEER.

Among the bridges constructed in the State during the last year is that built by The Connecticut River Bridge and Highway District Commission on Hartford avenue, East Hartford, Connecticut. This bridge took the place of an old timber trestle and is located 3,600 feet east of the Connecticut River on the elevated highway passing through the East Hartford Meadows. This highway is about 5,400 feet long and is raised most of its length from 16 to 24 feet above the adjoining meadows. The bridge is "dry" most of the year, being built merely to afford a passage for flood water.

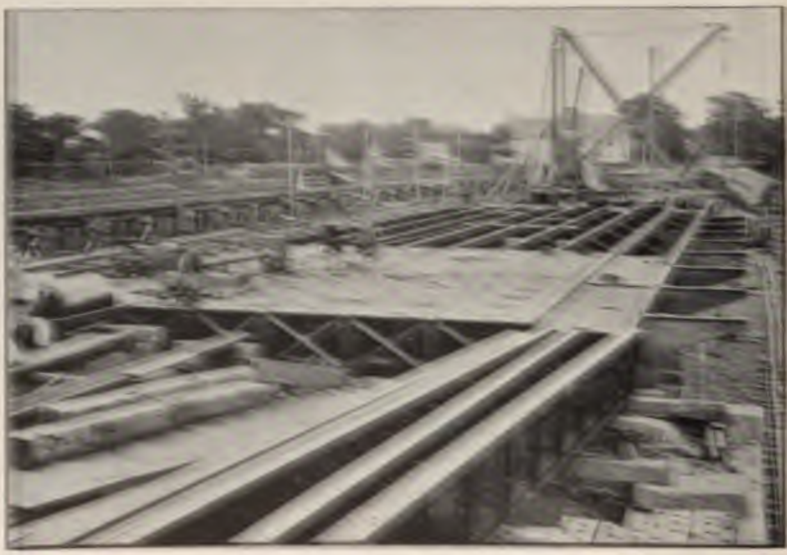


MEADOW BRIDGE, JANUARY 23, 1900.

The maximum flood recorded at Hartford is 29 feet 10 inches.

The highway is at elevation 34 feet. As it was desired to avoid the unsightly appearance of an overhead truss, the type of bridge as shown in the accompanying illustrations was constructed.

The bridge consists of 8 spans, 40 feet each, composed of 12 girders, 38 inches deep, spaced about 5 feet apart and rigidly braced. The sidewalks, 6 feet in width, are carried on brackets attached to the outside girders. The girders are covered with buckle plates "concave down." Above this is from 6 to 10 inches of concrete, supporting a sheet asphalt roadway surface 54 feet wide between curbs. Before the concrete was placed the surface of the buckle plates was covered with a coating of mortar, as a protection to the steel. The curbs are of concrete, protected with the "Wainwright" patent metal edging. The sidewalks are 4-inch blue stone, sawed on top and bottom surfaces, resting on three longitudinal channels.



MEADOW BRIDGE, AUGUST 27, 1899.

The piers, about 20 feet high above ground, are of solid ashlar laid alternately headers and stretchers. They are placed on piles spaced 3 feet c. to c. Top of piles are covered with 3 feet of concrete; concrete also extends down 12 inches from top of piles.

Top of piles are 6 feet from surface of ground. In the abutments, the body of the masonry back of the face ashlar is concrete.

To protect the piers from scour, there is placed beneath the bridge and on the end slopes a stone pavement 12 inches thick. This pavement extends out 75 feet each side from the centre line of the bridge.

All ashlar used was brownstone from the Brainerd, Shaler & Hall Quarries, Portland, Connecticut. Portland cement was used throughout the work, the brands being "Iron Clad" and "Alpha." Mortar was mixed 1 to 3; concrete mixed 1 to 3 to 6.

Before designing the bridge a careful set of core borings was taken on the line of the proposed structure. These borings disclosed firm bearing strata of clean sand and gravel about 20 feet deep, the top of which was about 6 feet below the surface of the ground. Hence, it was known definitely that piles of greater length than 25 feet would not be required. By this fact a considerable saving was effected in the cost of the sub-structure.

MEADOW BRIDGE, SEPTEMBER 2, 1899.

All the piles were driven by a steam hammer. As the driver struck from 70 to 80 blows a minute, the piles were driven very rapidly, four or five being driven in the time it usually takes to drive one, using the ordinary drop hammer. The girders were erected without false work by means of the "stiff-leg" derrick, as shown in the illustrations. All of the field rivets were driven by compressed air riveters, a portable plant being erected at the bridge.

The bridge has been found to be extremely rigid under passing traffic. Heavily loaded electric cars passing at full speed over the structure cause but a slight discernable tremor. Owing to the heavy roadway used, the noise of traffic is reduced to a minimum.

This bridge was designed and constructed under the personal direction of Edwin D. Graves, chief engineer of the commission.

MEADOW BRIDGE, OCTOBER 19, 1899.

The contract for the bridge complete was let to The Berlin Iron Bridge Company for $110,017. They sub-let the substructure to Weand & McDermott, 11 Broadway, New York City. Work was started on May 19th, 1899, and the bridge was opened to travel exactly five months later.

U. S. COALING STATION, NEW LONDON, CONN.

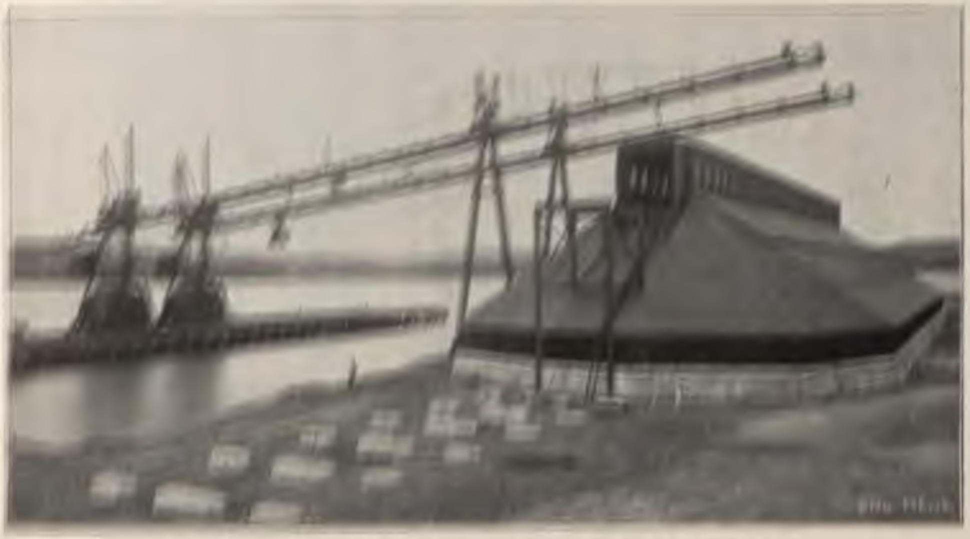
BY A. C. LEWERENZ, CIVIL ENGINEER, U. S. N., IN CHARGE OF NAVAL STATION.

On July 7, 1898, an act was passed by Congress authorizing the construction of a modern coaling plant at the Naval Station, New London, Conn., at an estimated cost of $200,000. General specifications were prepared by the Bureau of Yards and Docks, Navy Department, and bidders were invited to submit their own plans.

The contract was closed with J. W. Hoffman & Co. of Philadelphia on November 14, 1898, at their bid of $137,500. Active work on the excavation for the foundation began in March, 1899, and the contract was pushed throughout the summer as rapidly as possible, considering the difficulty of obtaining steel. Satisfactory tests of the operation of the plant were made on November 21, and the final details were completed, and the work accepted on January 8, 1900.

The plan of the coaling station includes a large storage shed, located on the grounds of the Naval Station, having a capacity of 10,000 tons, and connected with the dock front by two cantilever conveyers capable of being moved along the entire length of the building, and arranged to deliver or receive coal 25 feet beyond the face of the wharf. The plans also provided for the replacing of the old timber wharf under the conveyer tracks by a steel structure capable of carrying the new load.

The ground selected for the site of the coal shed had been filled in during previous grading of the station lands, and was not considered reliable; the foundation was therefore designed to carry the entire structure, with its contents. The site was excavated to the level of mean low water, and some 1,200 spruce piles were driven, at 5 ft. spaces, in longitudinal rows; the distance between adjacent rows varying from 3 feet along the middle of the



Coal Shed at U. S. Coaling Station, New London, Conn.
By Courtesy of the Engineering News.

building to 7′-6″ at the sides. These piles were cut off at a height of 12″ above mean low water, and capped with 12x12 yellow pine, on top of which was laid a solid floor of 12x12 timber.

The building is 290 feet long and 97 feet wide. Its walls rest on the timber foundation floor; the part below the shed floor level is of concrete (one, 3, and 6 mixture, Portland cement), and is 5′-6″ wide and 5′-3″ high. The upper part of the walls is of native granite, laid in ranged ashlar, 5′-6″ high, and battered on both sides. The pedestals for the two rows of columns along the centre of the building are of concrete, also resting on the timber grillage.

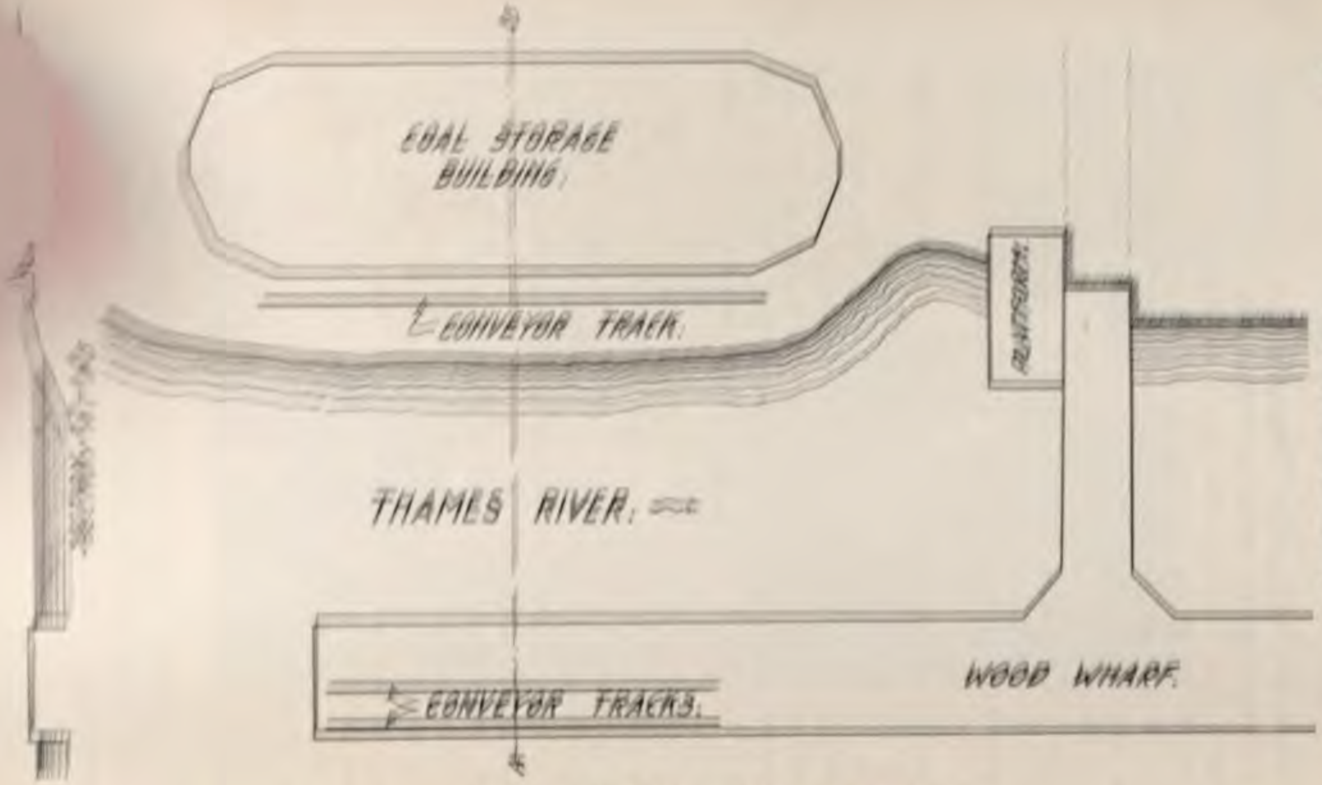
Upon the grillage was placed a filling of well compacted sand and gravel, topped with a concrete floor 12″ thick.

The superstructure is entirely of steel, with a corrugated iron covering. It is shaped so as to enclose, without touching it, the stored coal, and yet allow the latter to take its natural slope as it is dumped in from cars or through the hatches. The central columns are protected by sheet iron cylindrical jackets filled with concrete.

A lantern top on the roof contains a standard-gage railroad track, which is reached from the tracks of the N. Y., N. H. & H. R. R. by means of a trestle. There are 14 independent hatchways on each side of the building, giving a continuous line of openings its whole length, which are reached from the overhanging cantilever arms of the conveyers.

The conveying apparatus was furnished by the Brown Hoisting and Conveying Machine Company of Cleveland, Ohio, and consists of two of their patent bridge tramways, with cantilever arm, carried on steel towers which travel on a track along the wharf, and on A-frames which move on a rail laid on top of a concrete wall next to the building. The towers travel under their own power at the rate of 50 to 75 feet per minute; the A-frames are moved by hand. The bridges are constructed to permit of being skewed 20 feet out of a line perpendicular to the face of the wharf.

The operating machinery is located in the towers on the wharf, and is calculated to hoist 3,000 pounds at the rate of 350 feet per minute; it is guaranteed to take a loaded bucket from the



COAL HANDLING PLANT,
U.S. NAVAL STATION, NEW LONDON, CONN.

hold of a ship, dump it at any point on the bridge, and return to starting point, in one minute.

Coal can be dumped into the shed from hopper-bottom cars, or can be received by means of the conveyers from barges lying on either side of the wharf; it can be taken from the shed by means of the conveyers and delivered to a ship at the wharf; or it can be transferred directly from a barge on one side of the wharf to a ship on the other. Coal can be handled in automatic dumping buckets, with a capacity of one ton, in automatic grab or clam-shell buckets, with a capacity of 1½ tons, or in bags carried on steel skips holding two tons each.

The conveyers may also be used to handle stores or other freight, not exceeding five tons in weight, from ship to shore or shore to ship.

An interesting part of the work was the construction of the steel wharf to carry the travellers. The piles, consisting of Phoenix columns, weighing 38 pounds per foot, with special cast shoes, were driven on 16 feet centres in two rows, and securely braced and capped with steel beams, angles, etc. They varied in length from 45 to 80 feet, being proportioned to reach rock or to penetrate twenty feet into a bed of gravel, as shown by pipe soundings. They were driven exactly as a timber pile would be driven, with a 3,000-pound hammer falling 15 feet. The unprotected heads of the piles appeared to suffer no injury from the impact. It was found that but a few of the piles brought up at the expected depth; some of them refused to be driven to their full length and had to be cut off, while others went through the supposed ledge of rock on which they were to stop, and required splicing. It was also found impossible to drive them accurately into their relative positions, in consequence of which the lower struts failed to fit into the connections provided for them on the piles, and alterations had to be made, the necessary measurements being taken by a diver.

The work of the contractors was painstaking and satisfactory in every respect.

REPORT OF COMMITTEE ON OFFICE MANAGEMENT

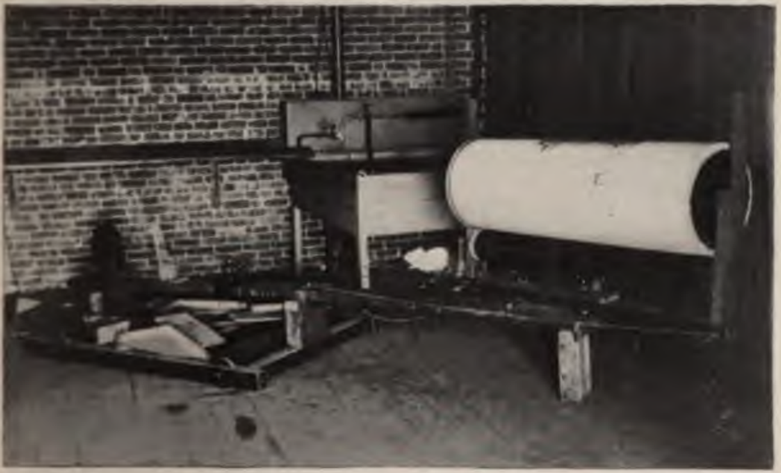
The Committee on Office Management respectfully submit that they have mailed circular letters to many of our engineering offices for data bearing on their subject, and, while there has been a very hearty and generous response to many of the letters, from a summary of those received we have concluded that we have not reached or heard from many who have undoubtedly improved their office system and management during the past year. The different offices throughout our State are operated under conditions, ordinances and charters so remotely different that to do justice to many of the larger offices of our State in the details of their management would require a separate paper for each. In some of our cities the city surveyor files all plans of the municipality with the city clerk as soon as they are completed, so that the surveyor is relieved of and the clerk encumbered with the responsibility of and future usefulness of these plans as soon as they are delivered. This scheme may or may not be of advantage to the city surveyor and citizens, according to the way it is managed at the city clerk's end.

The new work actually accomplished the past season is not very extensive, although the engineers seem to be cognizant of what is essential to efficiently classify and index their records and work, so that they may be of the greatest value to those who use them. Most of the changes have been small and mainly to perfect the different systems which seem to be already equipped to meet the demands made upon them. Several have added new plan cabinets, made so as to standardize as far as possible the sizes of maps.

Our President has moved into a new suite of rooms of the Connecticut River Bridge and Highway District during the past year, but reports nothing of value to our society from his equipment, but the directors new table, and the view from the windows.

Both of these are beyond criticism, but those who visit his office will note many ideas and methods in his system which are worthy of imitation.

Many of our engineers report the transition from the old style of book indexing to the modern flexible card index system, which is a move in the right direction. The city engineer of Hartford is now operating very successfully two separate card indices incorporated during the past two years, one for a general index to all plans in his office, the other for indexing field notes and city benches.



PRINTING FRAME USED AT CAMBRIDGE.

The city engineer of Providence, who is the custodian for as many plans as any engineer in New England, and who has always used book indices, is contemplating changing his index to cards, as the former method is becoming too bulky and cumbersome to be valuable.

Mr. Rudolph Hering of New York has a small safe in his office, which is used almost exclusively for his card index cabinet, which is built inside of and completely fills it.

During the past year I have seen some interesting blue printing devices which may interest some of our members. One is a pneumatic frame used by the Pratt & Whitney Company of Hartford. It consists of an ordinary rectangular frame such as we are accustomed to, except that it has an air cushion between the blue print paper and cover. After the tracing and sensitized paper are in position and the cover bolted down, by a stroke or two from a pair of hand bellows, the cushion is inflated and a uniform pressure forced down on the paper, pressing it tightly to the tracing and glass of the frame. Two other frames designed to overcome obstacles encountered in the new city hall of Cambridge, are instructive. Mr. Hastings, the city engineer, describes the problem and solution as follows.

PRINTING FRAME USED AT CAMBRIDGE.

"The situation here is such that there were no opportunities for constructing the printing apparatus of proper size and in the usual manner without special construction in the building, and this the architects were unwilling to consent to, so that the apparatus had to be designed to meet the unfavorable conditions which were found here. The printing frame has to be run through the windows of the attic, which are narrow (17"x40") in dimension. To enable a print of any considerable size to be passed through this window, I found it necessary to adopt the principle of the revolving drum. This drum is 53″ in circumference and 52″ in length, and is so arranged that it will just pass through the window, being held in place by a frame mounted on a travelling carriage, which is counterweighted by heavy iron weights. The frame is made to revolve by a small electric motor of one-quarter horse power capacity, and is controlled by cords operated from a carriage. The motor drives a small wheel with sand paper rim, on which the drum revolves. The drum is made of two circular ends of wood covered with narrow strips of wooden lagging and afterwards turned to a perfect cylinder; this is then covered with several thicknesses of cotton flannel as a pad or cushion. The tracing to be printed is attached to the drum with thumb tacks.

PRINT DRYING APPARATUS USED BY THE BERLIN IRON BRIDGE CO., EAST BERLIN, CONN.

"This machine has proved very satisfactory and well suited for this situation. The other machine is of the ordinary printing frame type, mounted on a travelling carriage and controlled by gears and levers attached to the carriage. This will print a sheet 21"x31". The photographs enclosed show the details of the printing frames very clearly."

To show a rapid method for drying the blue prints of our large engineering offices, I have secured a photograph of the drying oven used by the Berlin Iron Bridge Company. It consists of 15 or more sections a few inches wide, which slide out of the heated oven on round tie rods at the bottom. Each section has horizontal wires reaching from the front to rear face, over which the blue prints are hung during the drying process. The prints are dried in two or three minutes.

Mr. Arthur J. Patton, one of my associates on the Committee on Office Management, has furnished so complete and valuable a digest on "Office Management from the standpoint of a Land Surveyor" that I have appended it in its entirety to my report.

I will also add to this report the letters received from the city engineer's office of New Haven, the city surveyor's office of Middletown and the engineering office of Chandler & Palmer of Norwich. The individual reports of the above offices are so completely described that we consider them of great value to our members, and include them in our report.

Respectfully submitted,

(Signed) F. L. FORD,
A. J. PATTON,
JAMES H. EDWARDS,
Committee on Office Management.

SOME HINTS ON OFFICE MANAGEMENT FROM THE STANDPOINT OF A LAND SURVEYOR.

One of the most convenient attachments to a surveyor's office is an attic. Although everything necessary to life, liberty and the pursuit of happiness may be found in any attic of forty years standing, yet in some attics the articles above mentioned may be found more readily than in others.

Let nothing be thrown away, put it in the attic, orderly if you can, disorderly if you must, and let it keep the boys busy on a rainy day.

Let your attic be as fine as your purse will allow, but whether it be composed of beautiful oak cabinets or of cheap document boxes, let it be capacious. In a large office the attic will doubtless always be kept in order, but in small offices, where each person has a multiplicity of varying duties, it will become filled with a mixture of valuable material and rubbish and the spare minutes, rainy days and winter months will have to be utilized to weed out the rubbish and boil down the valuable material to such compact form that it may be stored away in a place of safety.

It is best, however, not to be too hasty with the rubbish.

When a lot which is not on a recorded plat is to be surveyed it is necessary to copy a number of deeds, possibly the deeds of a whole block.

It also may be necessary to get scraps of information from various sources, such as street lines, maps or sketches of maps, or notes of other surveyors. The surveyor copies only what is necessary to survey the lot and at the time has in his mind the connection between the deeds, but they are not usually in shape for a permanent record so he bundles them all together, marks them and places them in the box which is lettered to correspond with the name of the street on which the lot is located.

At the first opportunity his assistant takes the bundle, supplies the missing links, arranges the deeds in proper order in a book, together with such maps, street lines, or sketches as he may have and the record is complete. Now, if he and his assistant have done thorough work, he knows and can tell instantly the whole history of that block, he has simply made a recorded plat for his own use.

This is not a speculation; it is an investment.

The surveyor has utilized time that otherwise might have been wasted, the assistant has increased his knowledge of the records and has acquired habits of industry without which no ordinary man is successful and his clients are impressed with the fact that this office is a place of business and this is the best part of the investment, for it makes business. The record books recommended are in size 9½x7½ inches, have twenty-four pages, paper covers, and cost one dollar per dozen.

The books should be a complete history from the time the land was subdivided to the date of the survey; the original deeds and all other deeds that show changes being copied in full. It is well also to have a page of remarks, showing exactly what was done and the reason.

It is also desirable to add a map, if one is available or if one can be made from the deeds, and if the lots are not numbered in the deeds to adopt arbitrary numbers for convenience of reference. In the land business exact information on the moment is often of far greater value than the same information at a later period, and the surveyor who has the reputation of having such information on his tongue's end is much in demand.

Odd sketches and notes which have been collected from time to time and from various sources and which are not included in the above may be redrawn in a cross-section book, making it a sort of scrap note book.

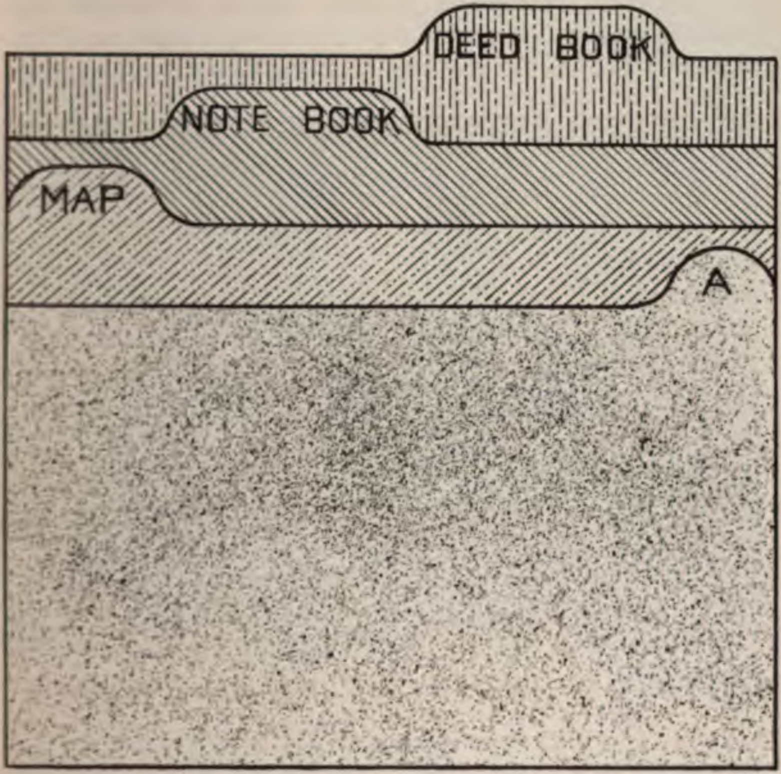
The traverse of all surveys should be calculated and placed in a survey book, together with the area and if possible the cost.

Surveys of the same area often differ greatly in cost, but from the average of a large number of similar surveys an approximate idea may be formed which will be of value.

It is possible for an article to be lost even when a person knows where it is, especially in an attic, therefore, it is best to keep the index up, no matter what else gets behind, and the only feasible index is the card system, for it will expand or contract, it is temporary or permanent, and no office is too large or too small for its use.

One drawer holding one thousand white file cards and one hundred and four index cards will serve to index the maps, note books and deed books of a moderate sized office, the cards costing $5.30 and the drawer possibly one dollar.

The white file cards may be ruled as desired, and each letter of the alphabet has four index cards, each of a different color and arranged as shown below.



METHOD OF MARKING CARD INDEX.

After taking the time and trouble to collect and arrange it is certainly wise to take every precaution to preserve these records. Probably most surveyors have a safe for their account and note books, but the manifest impossibility of obtaining a safe at a reasonable expense, that is large enough for their maps and yet small enough for their office has probably prevented may from giving the matter much thought. The safe here illustrated seems to fill the proverbial long-felt want.

It weighs but three thousand pounds, has accommodation for about seven hundred maps, beside leaving room for note books, deed books, etc.

It will take in a map 36x25 inches, and this width of 25 inches could be increased at a very little additional expense and is only limited by the size of the openings of the office.

Plan Cabinet in Safe used by A. J. Patton, Land Surveyor, Waterbury, Conn.

The safe costs $200 delivered, or less than 30 cents for each map.

Local conditions must of course control the details of any office, and these few hints are given, not with the expectation that they will fit every surveyor's wants, but in the hope that some portions may hit the mark, even if they do but provoke some one with better methods to fire back.

ARTHUR J. PATTON.

OFFICE SYSTEM OF CITY ENGINEER'S OFFICE, NEW HAVEN, CONN.

Our maps include four large roll maps, scale, 100 ft. to the inch, that give a detail plan of the city as divided into four sections. These rolls are copies of original rolls that became too much worn for use. Every house and lot, coast or harbor shores, streams and street and steam railroad tracks are shown. The rolls are supposed to be kept up to date, but we are behind now. From these rolls are being drawn sections 50 ft. to an inch, 28¾"x40" (with the further aid of the field notes originally taken). These sections are to relieve the amount of wear the rolls have had to stand and from tracings of the same black and white prints are to be made for use by the board of assessors. The numerous maps made for special purposes are kept in cases and indexed by reference to numbered sections shown on a small map of the city. Numbers are referred to drawers in case. Bridge plans, sewer detail plans and miscellaneous maps and plans are kept in cases, the drawers of which have each a descriptive tablet. Sewer maps, giving plan of street with bordering houses and lots, showing location of the sewer line, manholes, catch-basins, culverts, "hubs" for house connections and the house connections that have been laid, are in bound volumes. The index is framed and hangs over the case holding the volumes. There are now 12 volumes, and including unbound maps, there are about 750 sewer maps. Tracings of the maps are hung in six bunches in the office of the clerk of the department, for reference in giving permits for connections with the sewers. House numbering maps, which are small roll tracings, locate the proper numbers for the houses on nearly every street. Street and sewer profiles are filed in separate cases that are lettered with the initial letter of the street. Assessment maps for sewer and pavement assessment, made for the use of the Bureau of Compensation, are filed as profiles are, in lettered cases, but not kept separate. Our field books are indexed separately on front or back leaves, but we have no comprehensive indexing of such books except the sewer notes which are indexed by streets in a large book, which gives reference to grade, level and bench books. *Grade* means the daily work during the season in giving grade for sewer work. *Level* means profile work, and the term *bench* is of obvious meaning.

All of our instruments have been of Stackpole make, except the last transit purchased, which is a Buff & Berger.

Our office rates as follows: Cassius W. Kelly, City Engineer; Henry J. Kellogg, 1st Assistant Engineer, in charge of sewerage work; Henry H. Gladding, 2d Assistant Engineer, in charge of street and bridge work; Frank A. Mahoney, 3d Assistant; J. Frederick Jackson, Charles W. Merrels, Edward S. Nettleton, Frederick H. Osborne, George W. F. Gillette, transitmen and draughtsmen.

We have no rodmen. All of our force are graduates of a technical school, and the transitmen are competent to take up the work in case of temporary absence of an assistant engineer.

(Signed) H. J. KELLOGG.

ADDITIONS TO THE CITY SURVEYOR'S OFFICE EQUIPMENT AT MIDDLETOWN, CONN.

During the early part of the past year the Mayor of this city and the committee on streets and sewers authorized the city surveyor to have a case of drawers for maps built within the fireproof vault connected with his office. As constructed, it is similar in general design and detail to a similar case of drawers in the office of the city engineer in Hartford, Conn. At the request of Mr. Ford, chairman of the committee on office management of the Connecticut Civil Engineers and Surveyors' Association, a brief description of the case of drawers in the vault of this office is given.

The case occupies a space 8′-2″ by 4′-2″ by 5′-10″ high, and contains 50 drawers for maps and files, and 4 index drawers for card indexes. Two of the drawers are 5″ deep, and are 30″ by 48″ in size, and are intended for files of papers, or for any general use. Another drawer of the same size is three inches deep. The remaining 47 drawers are all 1½ inches deep and contain 118 compartments of different sizes, ranging from 12½″ by 20″, to 30″ by 48″. Each compartment will conveniently hold from 10 to 25 maps or drawings. The drawers run, or slide, on white oak splines, in grooves in the sides of the drawers, so as to avoid waste space. The drawers are of white wood with quartered oak fronts, and white oak drawer pulls, and with a brass label holder on each drawer for the number of the drawer. Each compartment is numbered on the top of one of the sides of the drawer or partition. A triangular piece of tin with the outer edge turned is set in a saw groove in each back corner of each compartment, one-quarter of an inch below the top of the drawer. These pieces of tin, 5½" long on the right angled sides, thus placed, are to prevent the back corners and edges of maps from getting up above the top of the drawer. The front corners are kept down by two pieces of stiff brass which are bent downward somewhat, and are cut into the top of the front of the drawer, or compartment, and kept in place by a screw on which, as a pivot, they may be turned out or in. In the bottom of the drawer, near each front corner of each compartment, is a hole 2 inches in diameter, which allows the corners of drawings to be pushed up from beneath, with the fingers of one's hand, so that the numbers of the maps may be readily seen, and to facilitate taking out or putting back any one or more of the drawings. These drawers being only 1½ inches deep will not be heavy even when full of plans, or maps, and if the splines are kept well waxed, the drawers will slide in or out very easily. The index drawers are amply large for the most complete system of card indexing, for all the drawings or papers of any description the case will ever contain, and for the indexing by the use of cards of different colors, of very much other matter not within the case. Its cost complete was $135.00. Its construction is such that it can be readily taken apart and removed if necessary without injury, or the top can be removed and more similar drawers can be added. It is amply large, however, to hold all the maps of the city for many years to come.

Permit me to add a few more words concerning the subject of card indexes. During the early winter months of the year 1899 advantage was taken of the greater amount of leisure time of that portion of the year, to make a card index of all the notes, maps and other drawings and files of papers for my private engineering practice for the past thirty years. A cabinet, of nine drawers was purchased from The Library Bureau, Boston, Mass., and the cards in several different colors for different purposes, of regular size and style suited to my use, with guide cards printed to order.

With only a comparatively brief experience, it is now considered indispensable, and much better and more handy than any ordinary index.

E. P. AUGUR.

OFFICE SYSTEM OF C. E. CHANDLER AND S. B. PALMER, NORWICH, CONN.

[illegible] having 64 pages [illegible] square inch, with vertical [illegible] The covers are [illegible] cloth. The books are [illegible] about 1000 books [illegible] these surveys [illegible] of owners in in- [illegible]

[illegible] and [illegible] kept [illegible] end. [illegible] made especially for [illegible]

[illegible] manila paper a large [illegible] the drawing [illegible] transparent [illegible] itself. [illegible] drawing [illegible] drawings and [illegible] numbered [illegible]

[illegible] having [illegible] transparent [illegible] multi- [illegible] paper and [illegible] more [illegible] containing [illegible] time [illegible] such a nature that they are not likely to be frequently consulted, we roll the set together and put them in a tin case 30" long and 2½" in diameter with cover. All plans in drawers and tin cases are indexed on cards and listed in a book. The cards are of course arranged alphabetically, while list of plans marked with any letter are arranged numerically.

All other rolled plans are filed alphabetically and indexed in a book, but it is our intention to extend the card index to cover them.

Descriptions written for use in deeds are filed alphabetically under the grantor's name in 4"x9" envelopes. Descriptions of new streets, grades for sidewalks, abstracts of titles and copies of land records, calculations of areas, solids, etc., material prepared for lawsuits and various other matters are similarly filed.

Newspaper clippings are placed in 3⅛"x5⅜" envelopes and special notes and references to special articles in engineering journals are made on cards of same size as these envelopes, and filed with them in card index form.

All municipal and other reports, magazines and catalogues in paper covers are given consecutive numbers and placed in ordinary book cases in the order of the numbers. All issues of same magazine and yearly reports of same city or department are given same number and are arranged chronologically. The magazines and reports are indexed on cards.

Bound books having names on backs are not indexed. No less than a dozen different classes of data have separate indexes.

Plans in progress or of work in progress until indexed are kept in special drawers.

Blue print frame is extra strong, has thick plate glass 26"x40" cushioned with harness felt ¾" thick, and is arranged to revolve laterally pivoted on center line and to turn up longitudinally pivoted at one end and runs out of window on a track. The window is larger than frame and has a single pane of glass, so that when printing frame is turned up against it the sash casts no shadow and prints can be made rain or shine. Prints are washed in running water and hung on brass or copper wire to dry.

All finished city maps are mounted and bound in books and deposited in fireproof vault.

(Signed) C. E. CHANDLER AND S. B. PALMER.

UNITED STATES GOVERNMENT WORK.

River and harbor improvements:

Connecticut River, 100,000 yards dredged @ 9 7-8 cents.

Thames River, 95,500 yards dredged @ 11 3-10 cents.

Pawcatuck River, 35,000 yards dredged @ 30 cents.

Stamford Harbor, 30,000 yards dredged @ 16 cents.

Five Mile River, 13,000 yards dredged @ 18 cents.

Norwalk Harbor, 10,500 yards dredged @ 19 cents.

Cos Cob Harbor 6,500 yards dredged @ 18 cents.

Mystic River, 450 cubic yards of ledge rock removed (depth of water 9 to 17 feet), @ $8.00 per cubic yard.

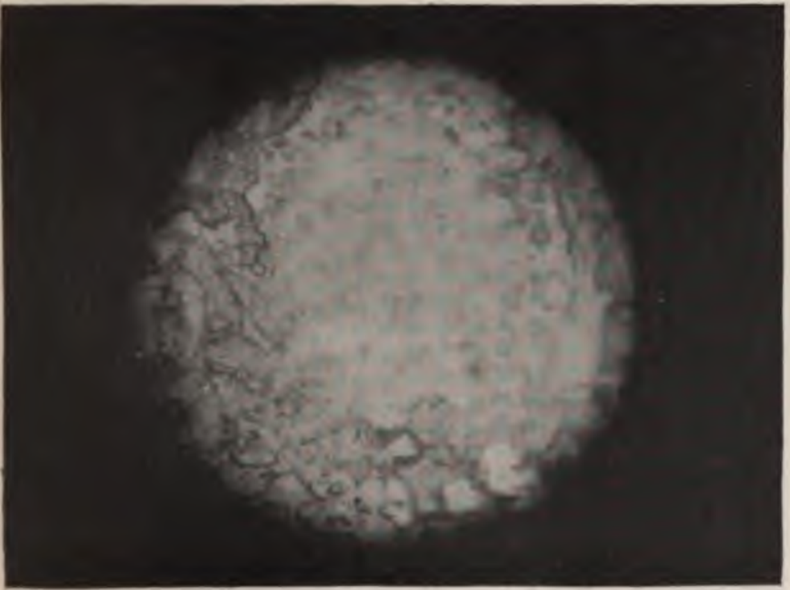
On the fortifications under construction for the defence of the Eastern Entrance of Long Island Sound, there were used about 195,000 lbs. of iron beams, 7,000 bbls. of Portland cement and 35,500 bbls. of Rosendale cement; the concrete placed amounted to about 36,000 cubic yards.

THE PHYSICAL AND HEAT TREATMENT OF STEEL.

BY HENRY SOUTHER, HARTFORD, CONN.

During the last thirty years steel has come into very general use for structural purposes. At some periods of this time its advance for building purposes has been very slow; the good reliable old brands of forged iron gave way slowly to the uncertain Bessemer steel. About all the steel used for structural purposes was known in the trade as Bessemer steel to distinguish it from "cast steel" made in crucibles, although both are cast into the ingot form as the first operation of manufacture. Many prominent engineers would not use steel ten years ago, and some will not even now. No less prominent an engineer than the chief of the P. R. R. corps refused to use steel in the bridges of the company up to the time of his death a year or two ago. Many of his close friends were at the head of steel plants, and had every opportunity to convince him of the merits of steel, but it made no difference, he would have iron. This feeling was not a blind prejudice, and rested upon many horrible examples of the unaccountable failure of Bessemer steel. Steel did fail when there was no reason for it assuming the steel was all that it should have been. It is now possible to look back and say what the probable causes of such failures were. The manufacturers of the steel knew but litttle of the product they were making and all is not known yet by any means. There were no easy means of testing and analyzing the product; steel works started without laboratories, but today the laboratory is considered as essential as the steel furnace itself. Every heat is analyzed as soon as made and the influence of the foreign elements that are in every steel is well understood by the men about the furnaces and carefully controlled. Such care wipes out all uncertainty of the varying composition of the steel.

Next in importance and perhaps quite as important is the heating and working of the steel. All of these points were disregarded during the early days of steel, and it is not strange that there were mysterious failures. Structural or soft steel, as it was called, was treated about as iron had been in the past; heated to almost welding temperatures for rolling or hammering and otherwise abused, as iron is by the average blacksmith today. It would not stand it and failed in an uncertain manner. Plenty of fine stock was used, unnecessarily fine in many cases, so that the composition of the steel was not always at fault, and it is almost certain that maltreatment during working was the cause of failure in most cases. It is an easy matter to take a rolled plate of the best of boiler steel and so treat it by heat that it may be broken by a slight blow of a hammer, and overheating or burning is not necessary for this either, merely a prolonged heat at low temperatures with slight rolling at the same time is necessary. This sort of treatment could easily be met with in rolling steel, and most likely was. A mysterious failure was the result. As usual, in similar cases the new thing, steel in this instance, suffered for the lack of knowledge in the producer and user of steel, and the use of steel was questioned in many cases. Mysterious failures of steel are becoming few and far between now, and it is to be hoped that there will be a reason found in every case of failure, for there surely is a reason every time. I will touch here upon the old theory of the crystallization of steel. When some member dropped off without cause it was said that the piece had crystallized as the result of strain. It is now known that the particles that go to make up steel do not change shape until so liberated by heat or physical treatment that it is possible. The hotter they get up to the melting point the more freedom they have, and the more they change, and the size of the grain increases with the heat. Unless heated, no change is possible in the form of the grains or crystals, as they may be called. What does happen when a piece of metal fails is hard to describe, but, in my opinion, it is the gradual lessening of cohesion between the grains themselves until so weakened as a whole that the steel gives away under a strain that it would hold indefinitely if under a dead load. It seems to take alternate stress either in the form of a vibration or minute bending, to cause breakage from fatigue. It will be asked why crystals have so often been found at the point of rupture and not elsewhere. The reply is that some time during the making of the broken piece it was heated in such a manner that crystals had time to form and of course the piece broke at the affected part. In fact, it is very difficult to break a piece in such a way as to show the crystals, even when known to be there. Breaking by alternate stress will do it better than any other way. I have broken many specimens by alternate stress that were as fine grained at the point of rupture as any steel as I have ever seen; there were no crystals; the steel was merely tired out. In ordinary soft steel it takes only about 300,000 to 400,000 applications of a load producing a strain of two-thirds the elastic limit wax fibre stress of the material to cause it to break by fatigue. The capacity of a piece to resist alternate stress seems to be directly in proportion to the fineness of grain. It should therefore be the aim of steel producers and workers to get the steel into such a condition. The best measure of the fineness of the grain of steel, leaving the microscope out, is the amount of reduction of area at the break under tension test. A fine grain is not indicated by great elongation. Iron is a familiar example of this fact. It elongates tremendously, but reduces in area but little. The grain of iron is coarse, although fibrous. To get a given steel into the finest state it should be heated and worked as near as possible to its critical temperature; for structural steel this is about 145 deg. F. The steel may be hotter at the beginning of the working, in fact, it must be, but at the close it should be near that temperature. If such a result is not possible, then annealing should be resorted to. This annealing must also be as nearly as possible at the temperature of recalescence or the critical point. If higher the steel will be just as soft, but the grain will be large and the reduction of area low; not the best condition to resist alternate stress. The fine grain may be also produced by a combination of heating and sudden cooling and in this direction I think there will be great advance made in structural materials in the future. I will furnish an example of this form of treatment later. There are one or two cases in common practice where the steel is left in what seems to me to be a most dangerous condition and where I know failures have occurred. One is the welded eye bar or tension member of a bridge. The bar from which the eye is made is usually very well rolled and finished at proper heat. In some cases as a first operation this bar is heated very hot and upset, this is not so bad as it is well worked with the hammer. Then the eye is pierced at a very high heat and with little work. This leaves the grain very large. The eye is then heated to a high temperature and shaped carefully, but with blows that do not thoroughly work the steel and it is thrown down to cool after having been heated very hot without any work at all, practically speaking. Within a few inches exists well worked steel and little worked steel, some that has been heated very hot and is large grained, and some that has been well worked and is fine grained. There are unknown internal strains caused by more or less sudden and unequal cooling and all this at a point where reliable material is wanted. After finishing all tension members that have been heated and otherwise worked should be annealed so that all parts of the member may have the same physical makeup, and be free from internal strains. The flanged head of a boiler is another point of a similar kind. The flanging heat is extremely high, requiring special steel and the work it gets after such a heat amounts to nothing. Such flanged heads should be most carefully annealed after flanging. Such is now the custom at some plants where they make a business of flanging boiler heads. The very finest of structural steel may be absolutely ruined by improper heat treatment in combination with improper working or physical treatment. The very worst of steel may be made to do good work if properly handled. A steel high in phosphorus will be much more injured by punching for rivets or shearing than a steel low in these elements. These elements cause the steel to granulate in the vicinity of the hole, and if broken across the hole in the testing machine by tension will show a crystalline fracture; steel low in these elements will not show the effect of punching at all, the fracture in the testing machine drawing down the same as if not punched at all. It would seem from this that the holes in cheap steel should be drilled, or punched and deeply reamed, and that the holes in good steel may be safely punched. This makes a very good argument to use the best steel every time. I have made a short series of tests to illustrate what may be done by heat treatment. The treatment has been excessive, so that the contrasts may be sharp. I will take them up separately and show microphotographs of polished sections.



No. 244. Boiler-Plate From Mill.

Specimen 244 is the plate as received from the plate mill. I assume it to be just as rolled, probably finished at a very low red heat, perhaps 1100 to 1200 deg. Fahr.

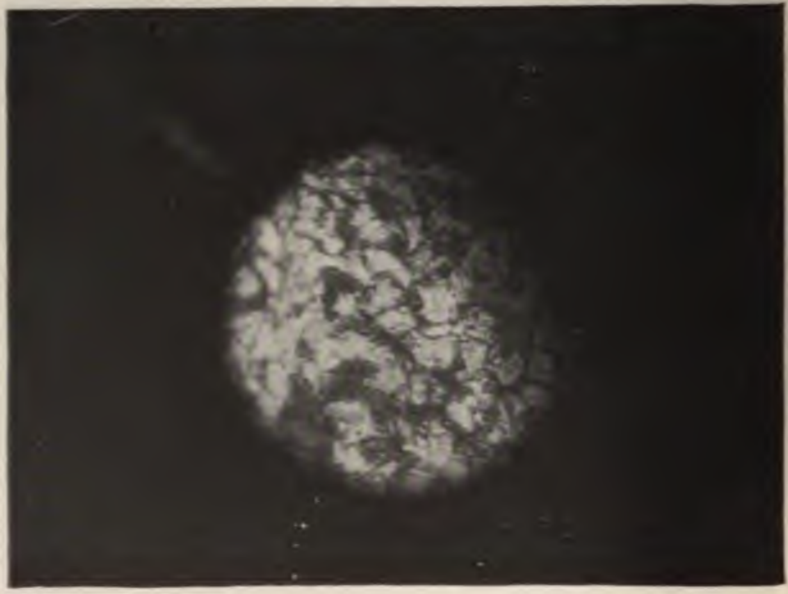
The analysis of the specimen is as follows. All the specimens I will show you as they were cut from the same plate:

Carbon .18%; Phosphorus .014%; Manganese .35%; Sulphur .013%; Silicon .008%; Copper .023%.

This was shipped to a boiler maker as ordinary boiler plate. It is in fact an unusually fine piece of steel and was most likely not exactly fitted for the purpose for which it was originally made and found its way to the boiler maker. The fracture and general character of the broken specimen show how good a piece of stock it is, as it came from the mill. The results of the tensile test were as follows:

Maximum strength per sq. in. 57,800 lbs.
Elastic limit per sq. in. 31,400 lbs.
Elongation in 8" 23.1%.
Reduction of area 64.6%.

The microstructure of the steel as shown may be called normal and if you will carry it in the eye the changes brought about by some of the treatments given will be very noticeable.



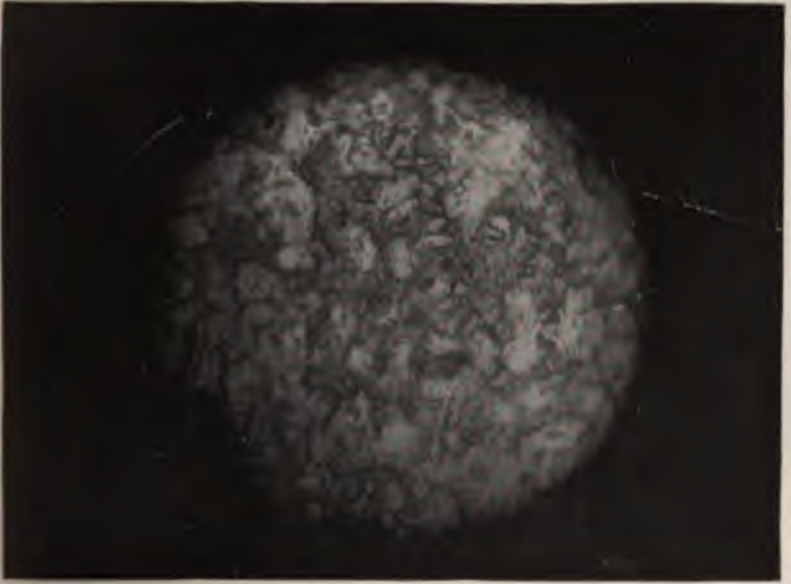
No. 249. Boiler-Plate Cooled Slowly From 1420° F.

Specimen 249 is the plate annealed at a temperature just above its critical point; that is heated to 1420 F., and cooled in a few hours in the furnace. The results of the test are as follows, and I give both tests for comparison:

	T. S.	E. L.	Elong.	Red.
Original..........	57,800	31,400	23.1 %	64.6%
Annealed.........	51,400	28,000	27.25%	52.5%

The annealing in this case gave a plate that is no improvement over the rolled condition. It is not as strong or as capable of resisting alternate stress or shock of any kind. The mill that rolled this plate knew its business.

There is little change in the microstructure of the steel; the grains are a litttle more regular in shape.

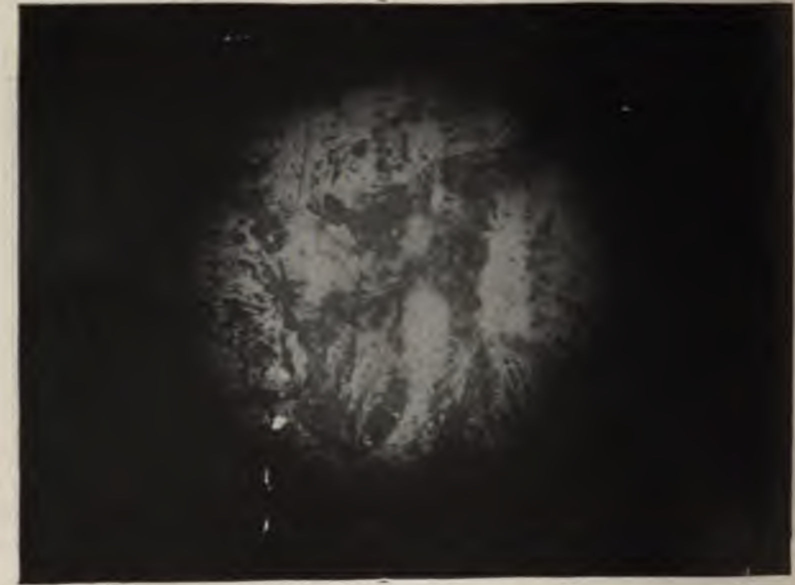


No. 246. Boiler-Plate Heated Yellow About 1800° F. Cooled in Air.

Specimen 246 is the plate heated to about 1800 deg. Fahr., and thrown on the floor to cool, about as an eye bar or flanged boiler head would be in good practice. The results of the test are as follows:

	T. S.	E. L.	Elong.	Red.
Original..................	57,800	31,400	23.1%	64.6%
After heating to 1800 deg...	55,400	25,800	29.4%	39.3%

Here there has been a decided change, and not for the better. The loss in reduction of area is the most serious, as it shows a very large increase in size of grain and corresponding loss in capacity to stand abuse. The increase in elongation does not compensate for this in my opinion. The elastic limit has dropped quite a little. In the microstructure of the steel an enlargement of grain is seen.

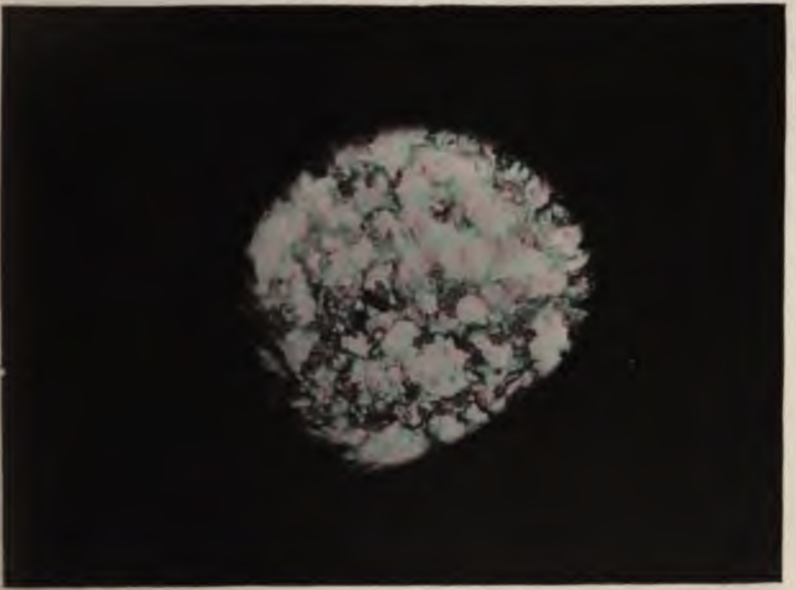


No. 245. Boiler-Plate Heated to About 1800° F. Quenched in Water.

Specimen 245 is the plate heated to about 1800 deg. Fahr., and quenched in water; very much as some plates and bars are treated to knock the scale off and give a smooth finish:

	T. S.	E. L.	Elong.	Red.
Original.........	57,800	31,400	23.1%	64.6%
Quenched at 1800.	100,900	Not defined	2.25%	7.7%

These results are very startling, and show what may happen if a man is in a big hurry and wants to cool the work off quickly. The fracture of the broken specimen does not look like the same piece of steel. The character of the grain as shown in the photograph is very different from the normal specimens, and shows a very different arrangement of grain.



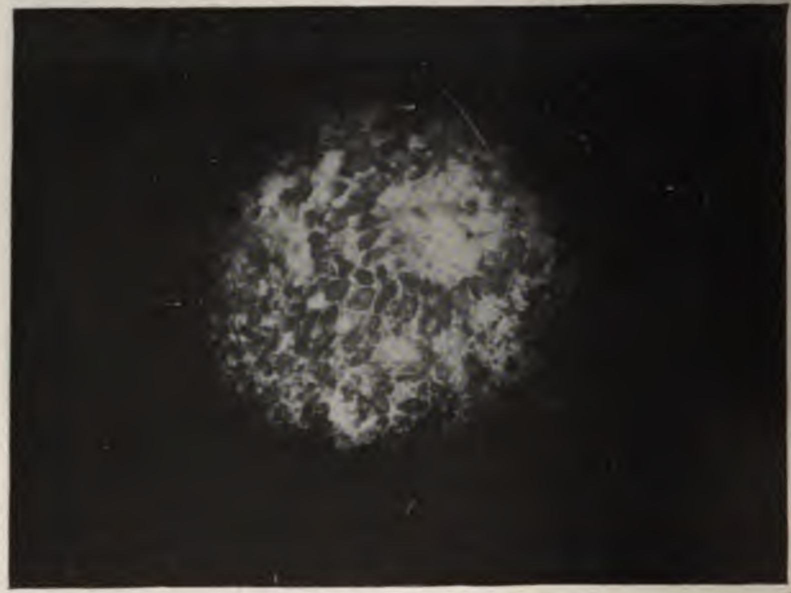
No. 250. Boiler-Plate Quenched at 1400° F.

Specimen 250 is the plate heated to a temperature just above the critical point, as for the anneal 1420 Fahr., and quenched in water. This is a treatment that I approve of most heartily and think will eventually come into use for certain structural members. It is applied now to expensive parts, such as steam ship shafts, gun tubes, engine frames, with varying modifications. I have taken the simplest form as an example. The results of the test are as follows:

	T. S.	E. L.	Elong.	Red.
Original..........	57,800	31,400	23.1%	64.6%
Quenched at 1400..	79,900	50,800	13.0%	49.4%

Here is an increase of elastic limit and tensile strength without any accompanying bad effects. The increase is about 60% in elastic limit. The elongation is much lower, but the reduction of area is still high. This specimen will resist alternate stress far longer than any of the others mentioned before. Some partial anneal following this quench would bring up the elongation very much without causing as great a proportional drop in strength and would make a still better specimen. The variation of this treatment is unlimited and I merely show the possibility by this one.

The grain as shown by the photograph is much finer than the normal.



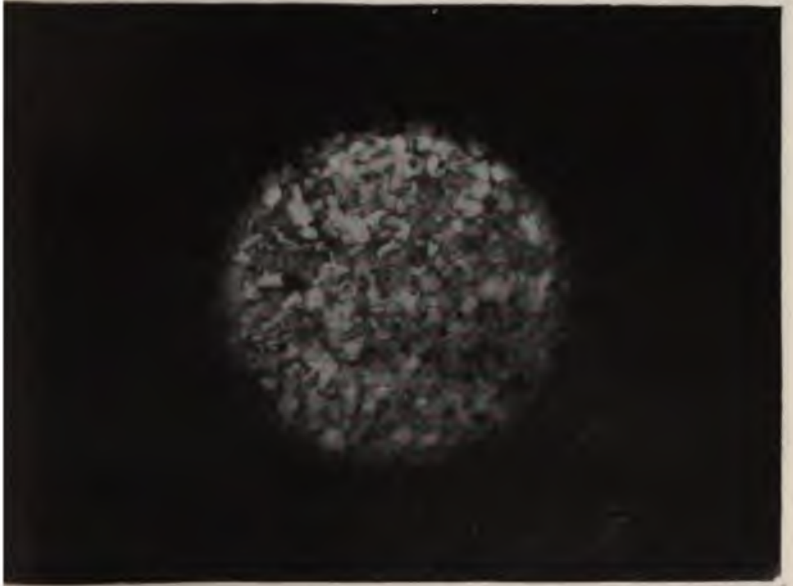
No. 251. Boiler-Plate, Forged Till Black.

Specimen 251 is a piece of the plate heated to a fair working heat and hammered until actually black. I made this experiment only to show the effect under the microscope.

	T. S.	E. L.	Elong.	Red.
Original..........	57,800	31,400	23.1%	64.6%
Hammered........	62,800	56,200	10.3%	44.1%

The effect of cold work is very noticeable in the increase of strength, but I do not think that the specimen is in as healthy a condition as in the case of the quenched specimen.

The grain as seen in the microphotograph is very fine and of a peculiar shape. Not at all like the normal specimen.

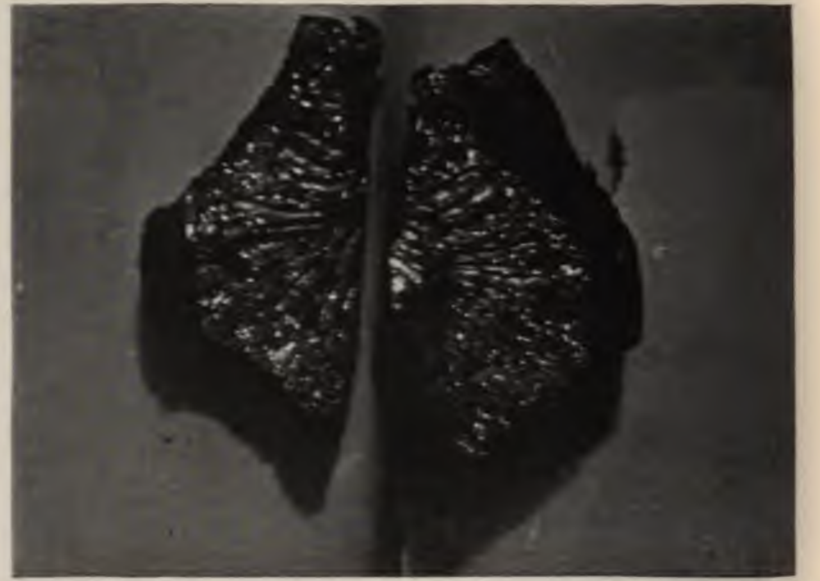


No. 70. 10 Per Cent Carbon Steel, Drop-Forged.

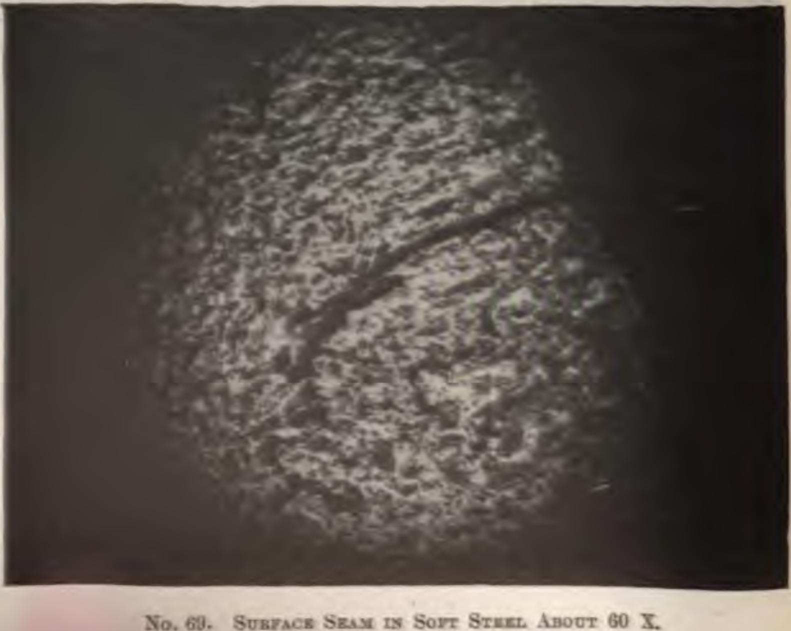
Specimen 70—This ordinary .10 carbon Bessemer structural steel was drop forged by a bicycle company into a fork crown. It shows a very uniform size and arrangement of particles. The steel is unquestionably in a good physical condition. It was probably worked until fairly cool, that is at a dark red heat.

Specimen 83—This plate shows two fragments of a ten carbon ingot, full size, which have been chipped off cold. The structure is plainly visible and shows the row of blow holes all around the edge nearest the surface of the ingot. This picture is the only one that is not magnified.

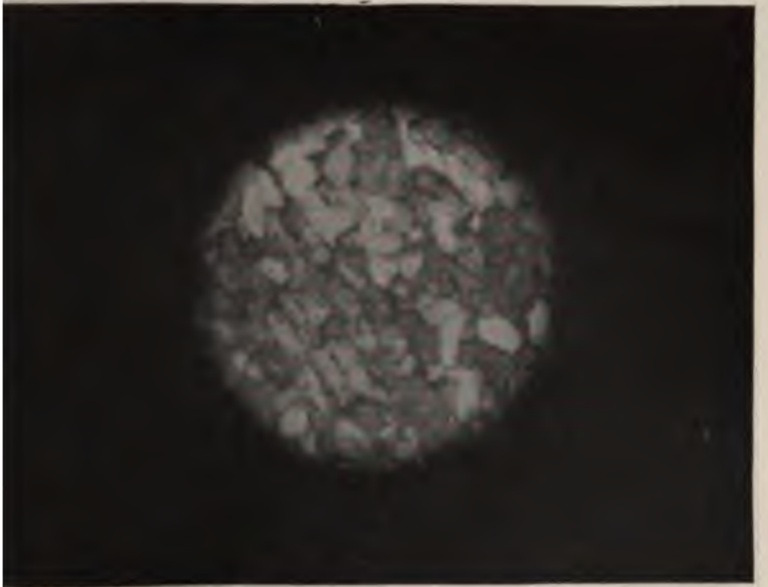
Specimen 69—This is a low power photograph of an ordinary surface seam, the surface of the plate being at the upper right hand corner. This picture shows a section below the surface and extending to the surface. It is probable that this imperfection existed from the time the ingot was cast.



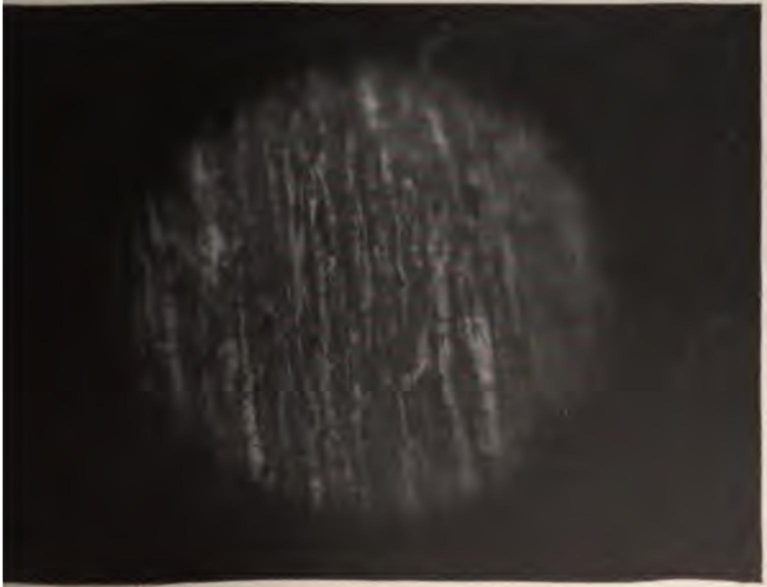
No. 83. Fragments of 10 Per Cent. Carbon, Steel Ingot About Natural Size.



No. 69. Surface Seam in Soft Steel About 60 X.

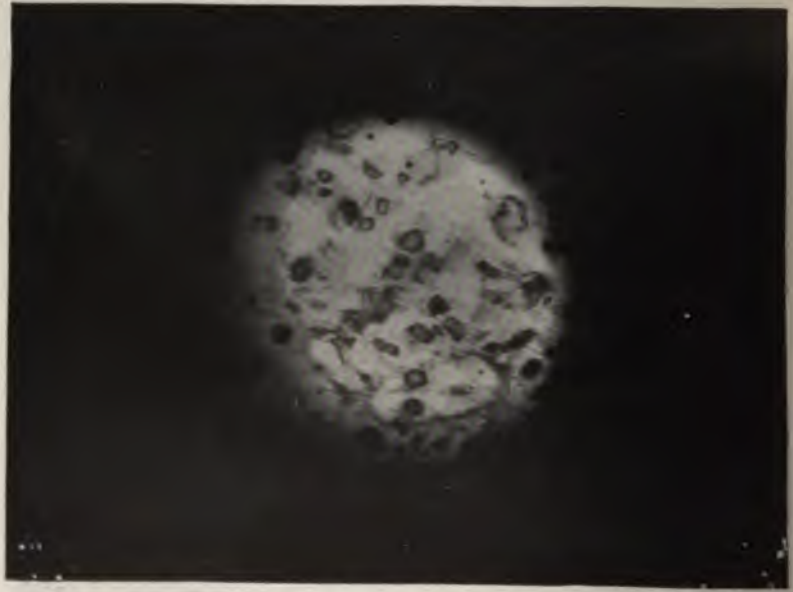


No. 71. Horsenail Rod.



No. 76. Finished Horsenail.

Specimens 71 and 76—This pair of pictures shows the effect of cold work on steel. The upper one is the section of the hot worked rod from which the horse nail is made, about ¼" by ⅛". The lower one is the finished nail after being worked cold from the rod to the horse nail shape. The elongation of the particles under the influence of cold hammering is very noticeable. Annealing at 1,400 deg. F. would restore these elongated particles to about the shape of the other picture.



No. 66. Soft Steel Piston-Rod.

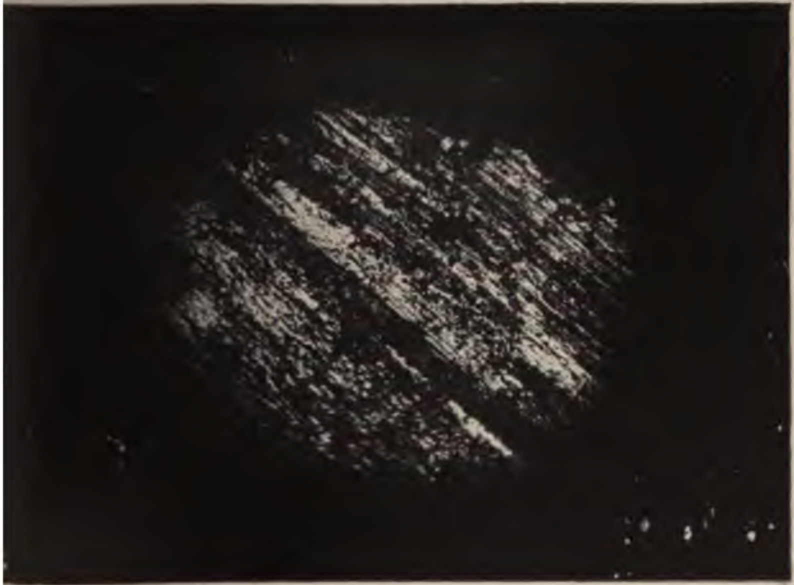
Specimen 66—This is a section of a piston rod of an air compressor that broke without apparent undue strain. The steel is as poor a grade of machine as is known to the trade, having the following analysis: Carbon .12%; Phosphorus .15%; Manganese .47%; Sulphur .05%.

The steel undoubtedly works easily in the machine shop. In this picture are distinct evidences of the tendency toward cubical crystallization; the natural formation of steel. It is very well marked and I show this picture particularly for this reason.

Specimen 37—This gives the appearance of a piece of wrought iron pipe under very low power magnification. This is the polished surface and shows the non-homogeneity of the structure of good iron.

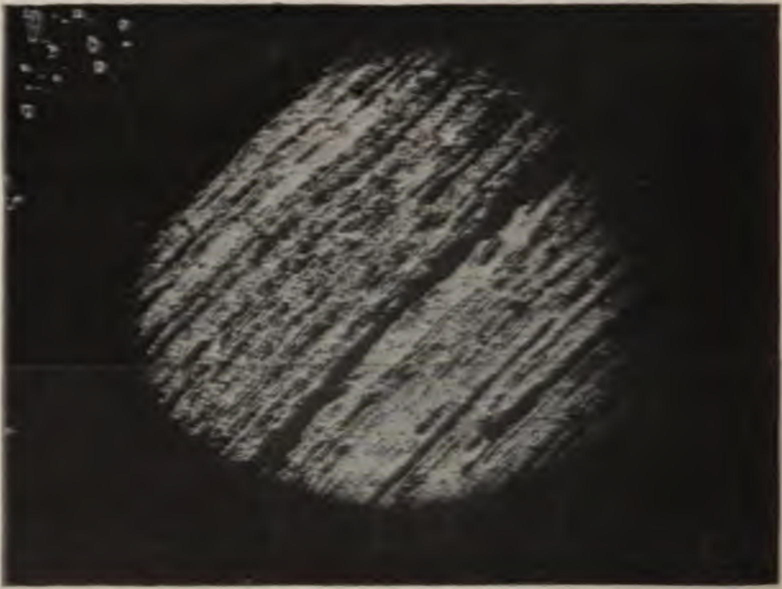
Specimen 40—This is the same piece of iron pipe, only it is the edge instead of the flat surface.

Specimen 38—This shows the end of the same sample or iron pipe. It gives a very perfect idea of the arrangement of the fibres of the iron; it being almost exactly what the eye sees when a piece of rope is cut with a keen knife.

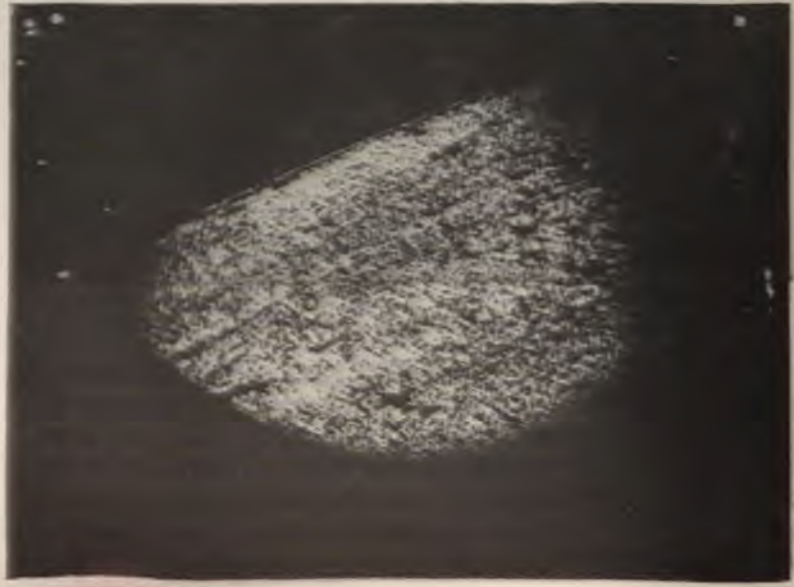


No. 37. Wrought-Iron Pipe, Outside.

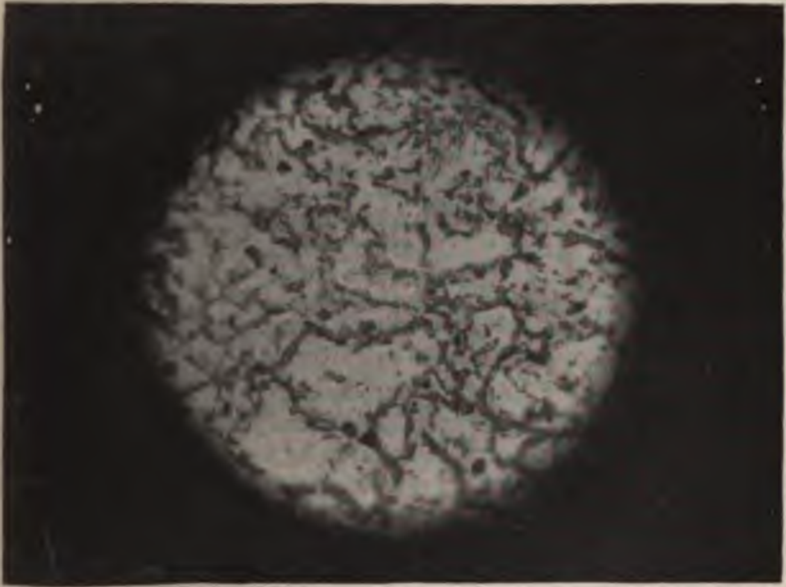
Specimens 55 and 56—This pair of pictures show the effect of sudden cooling on a .50% carbon steel. The upper showing the grains as they exist in the annealed condition; they are large, having had time to segregate in slow cooling. In the lower picture the grains are small and are about the size they were at the temperature to which this specimen was heated when quenched in water. Sudden cooling prevented any segregation.



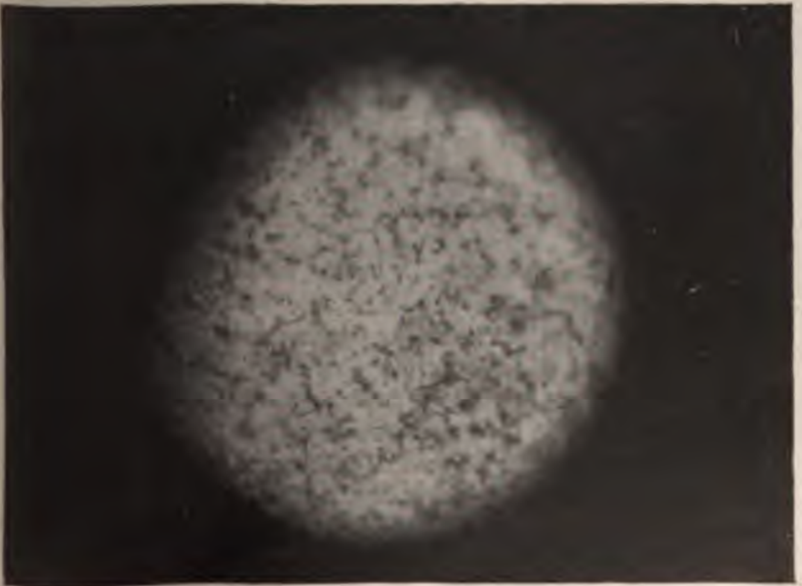
No. 40. Wrought-Iron Pipe, Transverse Section.



No. 38. Wrought-Iron Pipe, Longitudinal Section.



No. 55. 50 Per Cent. Carbon Steel, Annealed.



No. 56. 50 Per Cent. Carbon Steel, Quenched.

THE CO-OPERATION OF ARCHITECTS AND ENGINEERS.

BY GEORGE B. ROGERS.

It is with no small reluctance that I have undertaken to address you upon the subject of the Co-operation of Architects and Engineers, both because I am a comparatively young member of the society and for fear that I may inadvertently add to existing misunderstanding. There is a real necessity for doing so, however, and some one must start the movement with the hope that it will steadily gain momentum and finally result in a thorough understanding and amicable adjustment of our differences.

Between two such closely allied professions there is of necessity, in the present state of affairs, more or less friction; some with and some without cause, but mutual concessions will do much toward eradicating this condition, and they should be made whenever possible.

Our controversies, so unfortunate, have often afforded the public considerable amusement, particularly when some hasty member of either side has rushed heedlessly into print.

These controversies, particularly in public, should cease at once, and if differences there must be, why try and adjust them in private.

Neither profession can profit by the loss of respect from the public, and the differences cannot be adjusted in this way. Association intercourse and friendly relations can and will do more than all the newspaper controversies ever heard of, and if we conscientiously undertake to establish a common meeting ground and are prepared to give and receive with a truly liberal spirit, then there is hope for a bright and glorious future which we may all, as architects and engineers, share alike amid our mutual rejoicing.

The training for the two professions is practically the same in most of our institutions during the first, and in some cases continues throughout the second year. At this point our paths diverge, and the lines that each follow continue to differ radically.

The architect taking up the more artistic side of construction leading to advanced aesthetic perception, and developing all that is artistic in his nature prepares himself for a proper understanding of the most delicate adjustments of proportion, color, masses and lines, including necessarily, a thorough knowledge of the art works of the whole world.

The engineer, on the other hand, continues his studies along more practical lines. He receives a most elaborate course of training for investigations, researches and experiments, which are so valuable to his practice later in life. He goes into the most abstruse constructional problems, administration of great undertakings, strength of materials, chemistry, surveying, topography, railroad construction and economics, hydraulic and sanitary engineering, municipal engineering and many other extremely practical subjects.

This summary would seem to prove conclusively to any intelligent and impartial judge that, where any question of design is under consideration, it certainly should be the architect's province to make the final decision. On the other hand, it is equally clear that the subject of construction is best placed in the hands of the engineer. The field of the first to be the conception, and that of the latter to execute. This being the case, it is but natural to expect to meet with the works resulting from the joint efforts of the architect and engineer. This, however, seldom occurs, each side seemingly afraid that the other fellow will get a little credit out of it, and the result of this feeling is poorly constructed buildings, perhaps beautiful in design, and, on the other hand, good engineering works from a strictly constructional view, but decidedly lacking in artistic effect. Many opportunities for noble and enduring monuments are thus lost by a certain jealousy or petty feeling of wanting all the credit without stopping to think how much more creditable it would be to show a magnanimous spirit, work together and give credit where credit is due. Think what the people of the future will have to say. Here, I feel, is the place to apply the saying of John Campbell Sharpe: "The aim of all morality, truly conceived, is to furnish men with a standard of action, and a motive to work by, which shall intensify each man's selfishness, but raise him more and more above it."

With us a client places both himself and his money in our hands, and the responsibility is no light one. This responsibility has been discharged with great success, working harmoniously together, by the members of the two professions. I have in mind a beautiful gate-house in the reservoir system of Boston, which is certainly a monument to the architect and adds dignity and repose to the whole engineering scheme. The subway stations are another instance of engineering, where the architect has put on the finishing touches and exercised his aesthetic training.

These things cannot be accomplished by the two working independently, as their ideas would necessarily conflict to a certain extent, one viewing his work from the strictly economic and constructional side, and the other from the side of an art connoisseur, having no patience with hampering, economic restrictions. The proper proceedings would be for the two to consult, fraternize and understand each other, and by giving each his due amount of respect, create a feeling of comradeship and good feeling which cannot fail to produce good results. The unfortunate outcome of the lack of this mutual good feeling is evident on all sides, and the great pity is that these melancholy witnesses will very likely remain for generations.

It is just as simple a problem to the trained mind to produce ornamental construction which is proper, as it is for the untrained mind to produce construction ornamented, which is not proper.

The engineers would succeed much better and earlier if they allowed aesthetic influences to have some sway in their work, and their creations would certainly lift the masses to a higher plane by bringing them in contact with the beautiful, instead of brutalizing by forcing upon them their immense, uninteresting works.

The architect would also benefit human kind generally if he paid more attention to the absolute safety of his structures, by allowing the engineer to have some part in his work. By doing this he would gradually instruct the people to demand good construction, rather than seek the greatest display with the least safety consistent with holding the materials together.

The list of prominent engineering undertakings that have been carried through to completion and that are nothing more or less than brutal in effect, but practical in their workings, would occupy volumes. On the other hand, I can call to mind many accidents which have occurred by the architect ignoring the constructional points, either through carelessness or gross ignorance of their importance. Some of the causes for these accidents are to be traced to the best known of our firms.

There have been in the past, and are today, men who are perfectly capable of handling in more than a general way the works of both professions, but they are the exception, and we must all admit that it is extremely difficult to decide where the line is to be drawn.

The government buildings erected throughout this country, with few exceptions, are fair examples of fairly good construction with very poor design, simply because they were controlled by men of executive ability, but lacking that higher training which should characterize the thoroughly educated architect or engineer.

I cannot leave this subject without mentioning some of the great men that have gone before us, men who were masters of engineering and architecture, perhaps in some cases along special lines, but nevertheless entitled to honors from both professions: Brunelleschi, he who designed the great dome of the cathedral of Florence; Sanmicheli, the Italian architect, who later designed some of the greatest military engineering works of his time; Sansovino, who followed in Sanmicheli's footsteps; Vaubon, the great French military engineer, who always succeeded in obtaining good masses in his materials, and at certain conspicuous points developed the most beautiful features, features which are today historical and studied by all true artists; Violett LeDuc, the great architect and engineer of France, who died not many years ago, and coming down to our own times, Guastivino, the Spanish architect, who made such a thorough study of Roman construction, and developed the construction of the Guastivino arch, which is so universally used today.

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Referring to antiquity and drawing some conclusions, we find that the Roman Aqueducts have stood for over two thousand years, and can be seen today. These structures are studied by the whole civilized world.

We are building some immense masses of masonry also that posterity will be called upon to criticize and pass judgment upon and we have proof of the enduring nature of masonry in the above; therefore, we should be extremely careful of all points, both from an engineering and an architectural standpoint. Of all the professions there are none that assume greater responsibilities and must be prepared to carry them than those which we represent. And there are none that get less recognition from the public.

The public continually risk life and limb in their daily contact with architectural and engineering works, and we go on unconsciously laying up great monuments, the result of a vast amount of brain work and physical exertion, and yet when all is completed, we get a passing reference in some obscure corner of the daily papers, and there ends our share of the gifts which Fame has to dispense. 'Tis not so with the author, whose works are spread broadcast, and whose name is upon every one's lips. Gainter once said that the mistakes of an attorney can be corrected by the court of equity or appeals; those of the physician buried, but those of the architect (and I will add engineers) stand as a lasting monument of folly and reproach.

Taking these things into consideration, let us try in every possible way to unite our efforts, dispose of our controversies and act in harmony, and by so doing produce the best that is in us, and in course of time we may push our claims for recognition by the public and bring about legislation for the protection of the public and [illegible] of our own rights as competent professional men.

SPRINGSIDE SEWAGE DISPOSAL PLANT.

INFORMAL REMARKS OF MR. HENRY J. KELLOGG.

Mr. President and Gentlemen: I feel that I am in the place I have always been placed in—I am at the tail end! And it makes me think of what Judge Howland said at the Alumni meeting last June, when he remarked that President Dwight had held him always to the last speech; and said he, "Ladies and gentlemen, this will be the last time you will ever use me to sweep this room out!" And it looks to me as if it was my duty now to sweep out this room.

When I struck the town this morning I was loaded down with scientific ideas about intermittent filtration, and applications for membership of this society. I have unloaded the one this morning, and while sitting here I have unloaded all the science I thought I had.

As I sat here tonight and noticed the libations going on, I made up my mind that one and all of the members of this society believed in intermittent filtration! But I will guarantee one thing to you: if anything depends on the result you will wait a few days before you have the effluent tested!

Now, to come down to our plant at Springside.

Early in the fall of 1898 the need of disposing of the sewage from Springside Home was made urgent by a suit for damages, brought against the city by Charles E. Gorham. Mr. Gorham alleged in his complaint that damage to stock by the polluted waters of a brook flowing through Springside Farm, and thence through his pasture, the brook receiving sewage from a drain from Springside Home, had poisoned some of his stock, causing fatalities and sickness and ruining his business as a dairy farmer. This hastened the steps already taken in that direction. It was hoped that a connection might be made with the city's sewerage system. Careful surveys of all proposed routes showed that it would be practically impossible to make the connection along some routes, and a costly and doubtful undertaking along the best ones. The city engineer, Mr. C. W. Kelly, recommended to the committee of the Court of Common Council the adoption of the method of sewage purification called "Intermittent Sand Filtration." The committee reported favorably to such a scheme, and, by a resolution of the Court of Common Council, endorsed by the Mayor, the Director of Public Works was authorized to carry on and complete the work, by day labor or contract, as he thought advisable. The work was begun May 24, 1899, and put in use September 24, 1899, all by day labor.

FILTRATION BEDS UNDER CONSTRUCTION JULY, 1899, SPRINGSIDE, NEW HAVEN.
BED NO. 2 READY FOR BROKEN STONE.

The bottom layer of each of the three beds, which are each sixty feet square, is of 1¼ inch crushed stone, with some screened gravel of a corresponding size, and of an average depth of about ten inches. Under the crushed stone is a 5-inch sole tile drain, laid on boards, through the middle of each bed and lying east and west. The lateral drains, of 3-inch sole tile, are laid on each side of the 5-inch, connecting with it. The north bed has an extra pair of 3-inch drains at the west end of it, where the excavation cut into some soft red rock and exposed a few small springs. There has been no evidence that the springs have worked; but that may have been owing to the small rainfall of the last half of the year just ended.

The next layer is of about 2½ feet of coarse sand, and the next, or top layer, of 1½ feet of fine sand; the total depth of material being five feet.

The surfaces of the beds are level, and of the same elevation—43 feet above high water, city datum.

A few feet west of the middle bed is a tank or basin 18 feet by 20 feet, holding for discharge 3 feet of sewage. This sewage is discharged automatically by an 8-inch Miller siphon, special design, into a manhole built against the outside of the east wall of the tank. This manhole is fitted with three 15-inch wooden valves that control the flow into the 15-inch vitrified pipe conduits, allowing the sewage to be applied on one bed at a time.

Each bed is used for one day, resting two days. The amount of a single discharge is about 8,000 gallons, which is sent on to the beds in eight minutes. The number of discharges in 24 hours has not been definitely noted, as no one has watched during the night and no contrivance has been used to keep the tally; but a fair estimate makes the number of gallons per day between 50,000 and 60,000, which would show that the work done by the beds is nearly, if not quite, 200,000 gallons per acre per day.

The tank has an 8-inch overflow into the manhole, and an 8-inch opening at the bottom, also into the manhole, fitted with a brass flap valve. This valve is opened once daily during a discharge, and the contents of the tank stirred up, to force out the sediment.

The floor of the tank is lower than was intended, owing to circumstances that delayed the work when the tank was being built, and the necessity of getting the system working as soon as possible. It can be brought up higher, if thought advisable, at any time.

The sewer, from the tank to where it connects with the old 10-inch drain, about 500 feet from Springside Home, is of 8-inch vitrified pipe. About 1,300 feet is on a grade of nine inches in 100 feet, and the rest, 272 feet, is at 3½ feet in 100 feet. The steeper grade leads from the old drain to a manhole that drops the sewage 5½ feet. In this manhole is suspended a wire basket, of No. 5 galvanized wire, 1½ inch mesh, that breaks up the sewage matter and catches articles that might cause trouble in the lighter grade, or clog the siphon. It has already demonstrated its value. There are two baskets, as the filled one has to be carried away for disposal of its contents.

OUTLET OF BED NO. 3, TAKEN OCTOBER 28, 1899. SPRINGSIDE HOME, NEW HAVEN, CONN.

The sewer is carried over a brook in a concrete arch, which is of sufficient cross-section at the key to give protection against cold.

The concrete used was made of Alpha Portland Cement in the proportions of one of cement, two of sand and four of crushed stone (inch and one-quarter size); except in the abutments to the concrete arch, where it was made in the proportions of one of cement, three of sand and five of crushed stone.

The sewer runs straight between manholes, which are built at every angle. There are ten manholes, as a number of deflections were made to avoid deep cutting and rock excavation.

The tank has a portable covering, for use during the winter. The care used to keep the sewage from the effect of cold has resulted in keeping the beds from being unfitted for use by frost. During a recent cold spell the frost, in a bed that had rested two days, has penetrated 4 or 6 inches. At the first discharge the man in charge has punched a few holes through the crust with a crowbar, to hasten soakage, and after one dose the frost is out. The beds have worked all right without punching holes, but it is better to start the filtration at once.

The effluent, after the first week, has been as clear and odorless as spring water. I have seen one man drink of it, and heard him say that it was as good water as he had ever tasted. Prof. Herbert E. Smith, State Bacteriologist, expressed my sentiments when he said, that he preferred, as a characteristic of his drinking water, "innocence rather than repentance."

A test of a sample of the effluent, made by Prof. Smith, gave the following results:

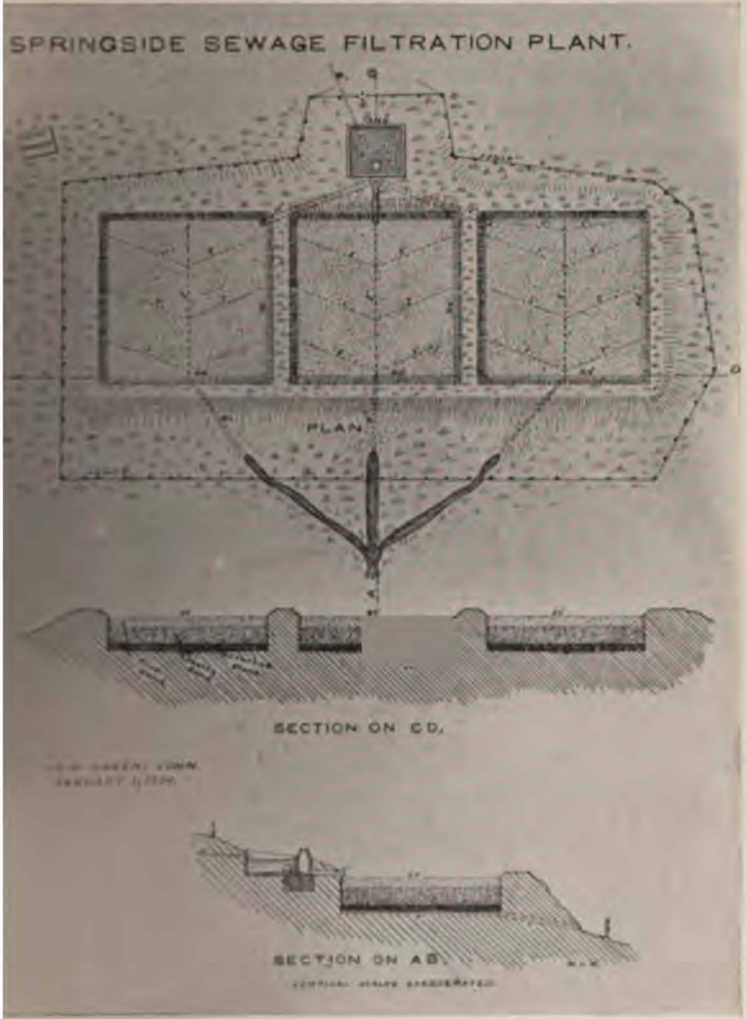
Free Ammonia	0,600
Albuminoid Ammonia	0,064
Nitrites	0,004
Nitrates	16,600
Chlorine	15,500 parts in 1,000,000

The cost of the plant, including every expenditure up to January 1, 1900, was $7,712.00.

The system throughout seems to be a complete success. It is too soon to pass a final judgment. The quality of the effluent compares favorably with that of other systems, and we expect to get better results later on. A reason may be given why the large dosage of strong sewage is so well taken care of by stating that extraordinary care was taken in building up the beds. It was necessary to economize material, as sand was not plentiful in that vicinity, and we had to buy a large portion of the coarser sand, as well as the stone, and the haul was a long one. We discussed the subject of septic tanks, but concluded that it would be cheaper and safer for us to treat the raw sewage by filtration.

Discharge of Tank Filtration Bed No. 3 at Springside, New Haven, Taken October 22, 1899.

The system is cared for by two inmates of the Home, which is the refuge for the city's poor.


SPRINGSIDE SEWAGE FILTRATION PLANT.
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PLAN
D
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SECTION ON CD.
SECTION ON AB.
VERTICAL SCALE EXAGGERATED

DISPOSAL DIVISION OF THE IMPROVED SEWERAGE SYSTEM OF PROVIDENCE, R. I.

BY HERBERT M. KNIGHT.

In prefacing this little talk upon the Disposal Division of the Sewerage System of Providence, it will be necessary for me only

MAP OF CITY.

briefly to outline the system of collection and interception, as helpful to the complete understanding of the work.

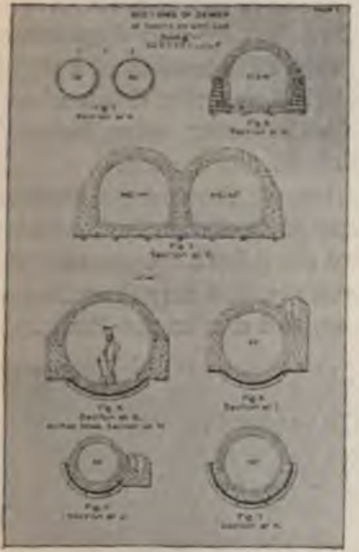
The city of Providence is divided by the Seekonk, Providence, Moshassuck and Woonasquatucket Rivers into four large drainage areas, known as the Seekonk River District, the Moshassuck River District, the Woonasquatucket River District and the Elmwood District, the latter being bounded on the south by a series of large ponds or lakes. In the eastern and northern parts of the city, the hills are high and the slopes rapid to the streams, making the question of sewerage and drainage comparatively simple. In the central and southern portions of the city, however, a different condition exists, the topography being very flat over the greater part of the area, with rapid slopes near the shore. The highest land in this section is only 85 feet above tide, and very large portions of it are between contours 75 and 80. In 1884, in view of the very filthy condition of the Providence River and its tributaries, it was decided to intercept all of the sewage then flowing by separate lines into those streams, by a line of marginal sewers, those on the east side of the city (the Moshassuck and Seekonk River sewers) being carried under the Providence River by a siphon, and uniting with the sewer carrying the sewage from the Woonasquatucket River District. The combined sewage from all parts of the city, except the Elmwood District, was then to be carried along the west front of the harbor, until it reached the southeastern extremity of the city at land owned by it, where the sewage was to be lifted some 29 feet in order to raise it to a height sufficient to permit of its treatment chemically, and subsequent discharge into the waters of the river at Field's Point. The Elmwood section being near the point of treatment, it was possible to provide for without pumping, and so discharges by gravity into the precipitation tanks.

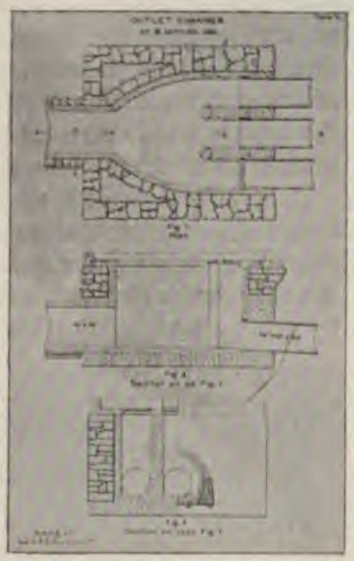
In the three drainage districts the sewage from which has to be raised, provision is made to take only a portion of the storm water; that which flows off at the first of the storm, carrying with it most of the filth upon roads and pavements, and slots are provided at the points shown on map by large dots, which cease to allow sewage or storm water to flow, when the flow in the intercepting sewer reaches the level of maximum capacity, the surplus being discharged through double tide gates into the streams. In the case of the Elmwood District nearly the entire storm water had to be provided for in a large storm water sewer, the section having no natural outlet except in the extreme southern portion.

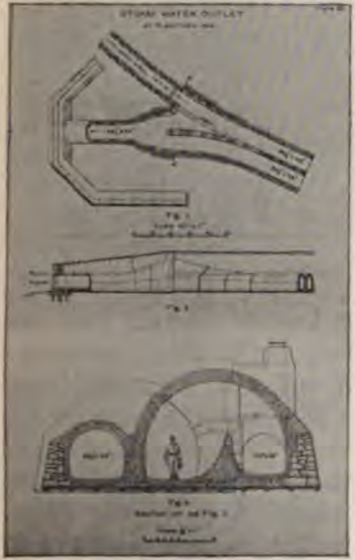
As the Elmwood District was a rapidly growing residential section, with a crying need for drainage, it was decided to relieve this portion of the city first, and the disposal portions first constructed, were pushed with this object in view, but provisions were made for connections with those portions of the original scheme, which were to be built later.

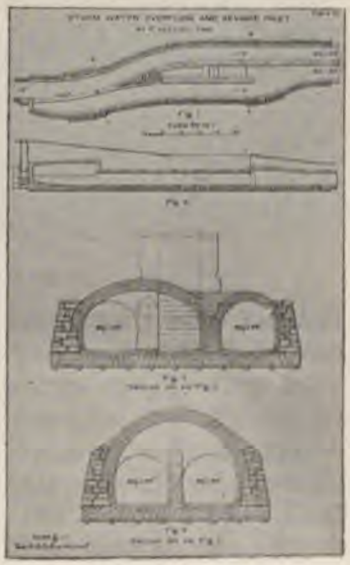
There are few items of great interest in connection with the portions of the disposal sections first constructed. Starting at the point of discharge, the line consists first of a double line of 48-inch cast iron pipes, 35 feet below mean high tide, with their discharge ends level with the bottom of the river at that point. These lines are used alternately, if the quantity of sewage flowing is not too great, the increased quantity and velocity tending to scour out the pipe and keep the river end free and clear. At the harbor line these pipes run into a gate house or outlet chamber, in which are screens and gates for removing solids, and for regulating flow. Provision was made in the construction of this chamber for the third pipe, which may eventually be required. At this point begins the sewers proper in a 70x76-inch brick sewer, with rubble haunches. This runs only a short distance along shore of this size, when it reaches the storm water outlet bellmouth, which is really two intersecting bellmouths. Its purpose is to act as a relief to the sewage sewer at times of storm and high tide, and has a granite weir, with its crest 1 foot above mean high tide, at one side of the sewage sewer, permitting the surplus sewage to overflow, and discharge through the storm water outlet into the river.

From this point the sewers continue as a double concrete construction with 4-inch brick lining, through and across the tank area, to the storm water overflow and sewage inlet. At the east side of tanks it is broken by a rectangular effluent well, with openings to receive the effluent discharged through the tanks by six different channels. This being a complicated construction, time forbids description. The storm water overflow consists of a


SECTIONS OF SEWER


OUTLET CHAMBER


STORM WATER OUTLET


STORM WATER OVERFLOW AND SEWAGE INLET

bellmouth, in which is a weir to permit of the excess of storm water coming from the Elmwood section, flowing into deep water through the sewage sewer. The sewage inlet consists of a flight of stairs at the entrance to the precipitation tanks, down which the sewage flows untreated into the outfall sewer, when, because of dilution or other cause, it is not chemically treated.

As previously stated all that portion of the sewage coming from the central, northern and eastern parts of the city has to be lifted after reaching the lower part of the Allen's avenue section, in order that it may be treated chemically, and may flow thence by gravity into the Providence River, and it is to the Pumping Station for elevating the sewage, that I would next call your attention. This is situated at the western end of the property devoted by the city to sewage disposal, and some 3,500 feet from the precipitation tanks, and nearly a mile from the point where the sewage enters the waters of the river. In its essential materials it consists of a concrete substructure, and a superstructure of brick and limestone. The sewage coming from the city flows through a 102" circular brick sewer, with a constant grade of .05 per 100 feet. Just before entering the pumping station it passes through a sump or sand catcher 30 feet long and of the regular

Storm Water Bellmouth.

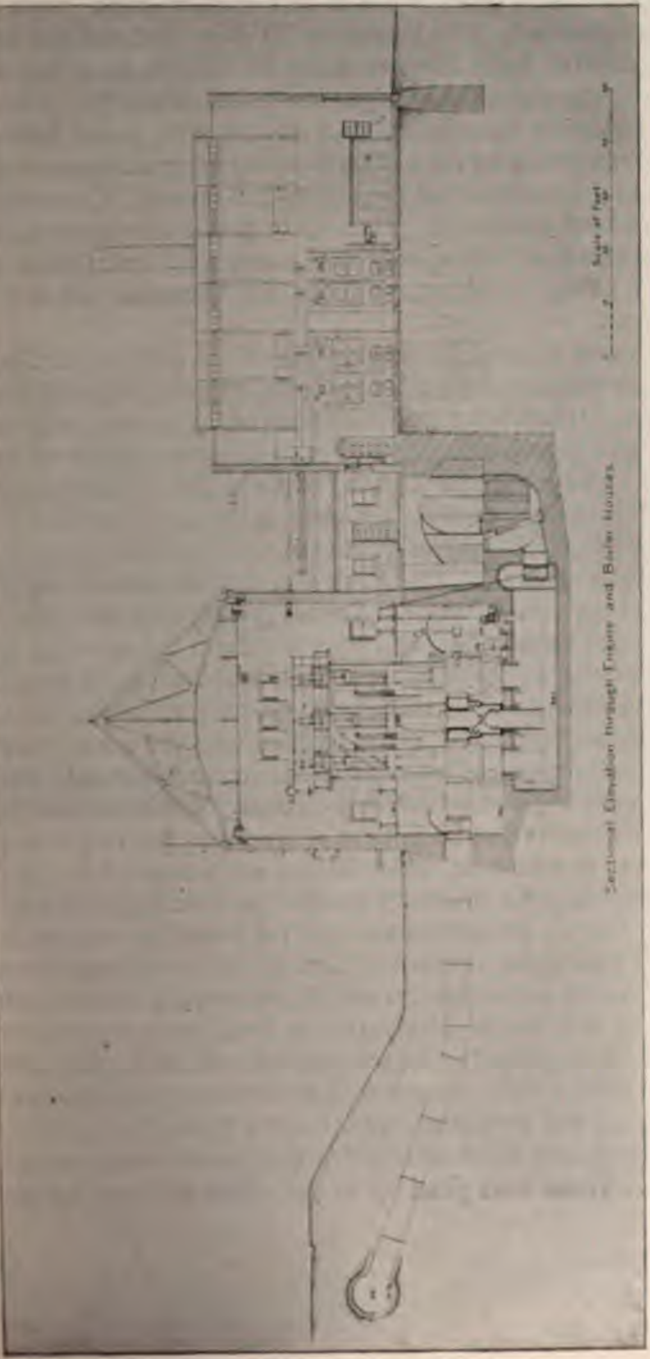
width of the sewer, designed to intercept and hold a portion of the sand which is brought down in great quantities, especially after a storm. A very large percentage of the sewage flowing at certain hours in the day is the result of wool washing, in which process is liberated a very large amount of exceedingly light, fine sand. This is so completely held in suspension, that no ordinary method of settling, such as is provided here, would be at all effective in retaining even a small portion thereof, and consequently all except such of the heavier street detritus as is carried along by the small proportion of the storm waters that enters the sewers, is carried through and beyond the pumps, and is taken care of in the roughing tanks of the precipitation plant, to be spoken of later. The sand sump is covered by a large domed manhole, so shaped as to give access throughout its entire length for an ingenious scoop or dredge, operated by hand power, by means of which it is periodically cleaned. This sand catcher is located in the pumping station yard, in close proximity to the buildings.

After passing the sand sump the sewage enters the screen chamber of the pumping station, in which all larger solid matters are removed from the sewage before it reaches the pump wells. This screening is effected by a double set of screens. The first screening takes place in that portion of the screen chamber known as the filth hoist house. Here are located 4 semi-circular screens or cages, with round iron rods or slats about 1″ apart, through which the sewage passes before entering the screen chamber proper. These cages with their wide openings are intended to intercept the larger solids brought down in the sewers, and so relieve and reduce the manual labor necessary in the care of the finer screens or slats beyond. The cages are separated by T beams, and are counterweighted so as to be lifted when full, to the floor above, where their contents can be removed and spread upon the slat iron floor for the moisture to drain out, and the cage immediately returned to its location in the conduit. The cages have solid bottoms like the half of a barrel head, and thus retain nearly all the matter which they intercept, when raised for the purpose of cleaning. In order to prevent the flood of sewage rushing through the opening which would otherwise be left when a cage is raised, two doors are provided for each cage, which are shut by the flow of the sewer when the cage begins to arise, and thus force it to go through the cages which are still in service. In practice more material is retained upon these cages than is desired, as the paper of which there is a very large amount brought down, clogs up the openings between the rods very quickly, and requires more hand labor in this part of the screening than was desired.

The finer rack or screens next beyond the cages, extends longitudinally the entire length of the screen chamber, covering the openings to the four pump wells. It is made of oak slats some 6″ deep, separated ½″ by bronze separators. This rack is set at such a slope as to be comparatively easy to keep clean and clear by a workman constantly moving back and forth along its length, who rakes the matters which are retained upon or between the slats to the platform, from whence they are transported, together with the material collected from the cages, to the ground floor of the filth hoist house, and from which they are sent to different portions of the city's property adjacent, and dug into the soil.

In passing these finer screens the sewage turns at right angles with the direction in which it has been flowing, and enters the pump well through a 48″ valve, by means of which each pump well may be shut off from the screen chamber. The bottom of the pump wells are all at the same elevation, and each is 1 foot lower than the elevation of the screen chamber floor which is level after reaching the westerly end of the inclined screen. Projecting into the pump wells are the throats of the three suction pipes of each pump. The bottom of these are two feet above the floor of the pump well and are thus 1 foot below the bottom of the screen chamber. By this construction it would be possible to have the screen chamber become empty, and still have a seal upon the suction pipes of the engines, sufficient to prevent them from drawing air and running under a vacuum. The pump wells are irregular channels having curved sides and bottoms with a flat floor and roof of small radius, thus making the larger part of their area effective for conveying sewage to the throats of the suction pipes, and reducing the remainder to that amount necessary for convenient access for construction and repairs.

The sewage is lifted through the pump chambers and the 48-



Sectional Elevation through Engine and Boiler Houses.

inch force main pipes to the 88-inch circular brick "force main" sewer, so-called. The maximum lift is 29 feet and the average from 22 to 24 feet. After reaching the 88-inch sewer the sewage flows by gravity to the precipitation tanks. Upon the 48-inch cast iron discharge pipes is located a 48-inch gate, placed horizontally, designed to shut the pumps from the force main sewer so that they may be entered for inspection and repairs. The number of pumps now installed is 3, but every provision was made in the construction for the speedy and economical installation of the fourth pump, which was planned for, whenever the city shall require it.

The spot selected for the location of the pumping station was in a salt marsh, which was overflowed at every stage of the tide. The top surface was a peaty marsh-mud. This was underlaid by sand and gravel, accompanied with large quantities of ground water. The contractor decided to make his excavation without sheeting, as the area of the foundations for the engine house alone was 48 by 90 feet, and he was not allowed to leave posts or bracing in the concrete. The result was that the surrounding earth fell into the excavation over a much greater area than that called for by the foundations, and thus increased the quantity of material actually removed by nearly half the actual cubic contents of the foundations. This increase in quantity of earth, due to the unstable and unshored banks, coupled with the great amount of water, and the exceedingly dangerous nature of the sand encountered, made the excavation very difficult. As the excavation approached the level of the bottom of the concrete a very fine quicksand was encountered, which baffled every attempt to get down to the grade of the bottom of the work, so as to begin placing concrete. Finally the contractor used the following method, which proved thoroughly successful. Leaving his work upon the whole of the area as he had been attempting previously, he concentrated his gang in a line as closely as they could work, one behind the other, and dug rapidly a trench one and one-half feet below the intended bottom of the concrete. Into this trench, as rapidly as any small part was excavated, were thrown burlap bags, which had been previously filled with a dry mixture of sand, cement and gravel. These were piled up to and above the level of the surrounding quicksand. These trenches were dug so as to block out or isolate small squares or parallelograms of greater or less area, as the circumstances made necessary. These dams were allowed a few days for the concrete in the bags to set, after which the area surrounded was excavated easily to depth below that called for on the plan, sufficient to lay a concrete bag floor, similar to the dikes or trenches, one and two bags deep. The small dikes prevented the sand from flowing as quickly as previously, and the bag floor gave a solid and uniformly dry surface upon which to begin the placing of the concrete for the substructure. The scheme has proved itself adapted to the conditions and no settlements have occurred since, over the area so treated.

Excavation for Pumping Station.

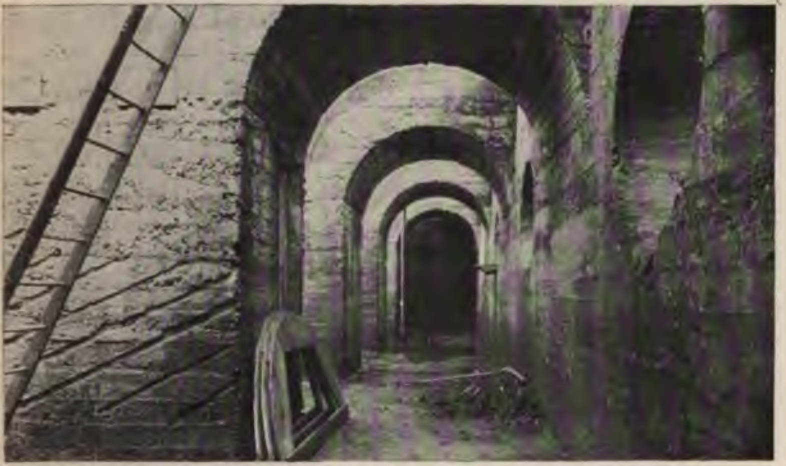
The entire substructure is Portland cement concrete, except a four-inch lining of brick masonry laid in Portland cement, used in screen chamber and pump wells to prevent the wear which might possibly result to an unprotected concrete surface. The walls and superstructure of the engine house rest upon concrete walls, offsetted from the lowest portion of the pump well foundation, and whose lowest point is 10 feet higher than the greatest depth of excavation. On account of the method followed by the contractor the earth beneath this overhang had all run out, and it became necessary to restore it.

Large cobbles and rubble stone were brought and forced into the soft sand by impact and ramming until the earth refused to receive more. Upon this made foundation the supporting exterior walls were commenced, and after the settlements which occurred after or during the placing of the first few layers of concrete, the walls reached a permanent bearing, at which point they have remained without further settlement.

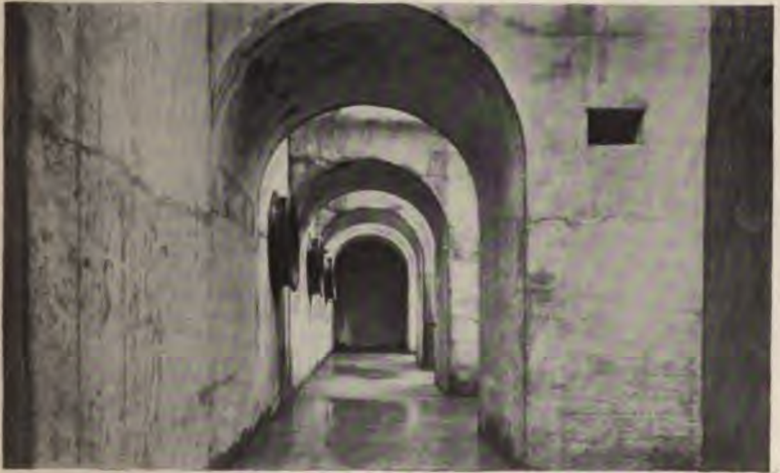
When foundations were nearly done a leak of large dimensions sprung in the screen chamber and the method pursued in stopping it may be interesting. Two holes, large enough to receive 2-inch pipes were drilled through the entire thickness of concrete into the earth beneath and through them 2-inch wrought iron pipe were put and concreted in, the water being allowed to flow through the pipe in sufficient quantity to reduce the pressure until the pipes were thoroughly set in their position. Cement grout was then forced into one of the pipes under pressure until it refused to take more. A day was then left for the grout to set up, when upon opening the valves at the top of each pipe it was found that no water flowed and that the leak was stopped. The pipes were then cut below the brickwork of the screen chamber and bricked over.

As will be observed by the transverse section of the engine house preceding, there are no openings by means of which fumes or odors can enter the engine room from the sewage channels or pump wells, the walls being solid without openings except for the rods of the inlet gates, which are gasketed. From the screen chamber and filth hoist house two 4-foot channels connect with the air space of chimney surrounding the flue and by this means, coupled with ample fresh air inlets, so designed as to present, by means of swivelling bonnets their openings toward the wind, the air in the screen chamber and other parts of the sewage channels is fresh and free from disagreeable or dangerous odors. The conduits, by means of which the foul odors are carried to the chimney to be discharged with the heated gases and smoke are made in the heavy concrete wall of the screen chamber. Above each 48-inch gate is a peculiar "basket handled" manhole so formed as to permit the removal of the gate for repairs in case it should be necessary.

The concrete of which the foundations were made was composed of 1 part cement to 2 of clean, sharp sand to 5 of gravel.



Concrete Foundation Before Plastering.



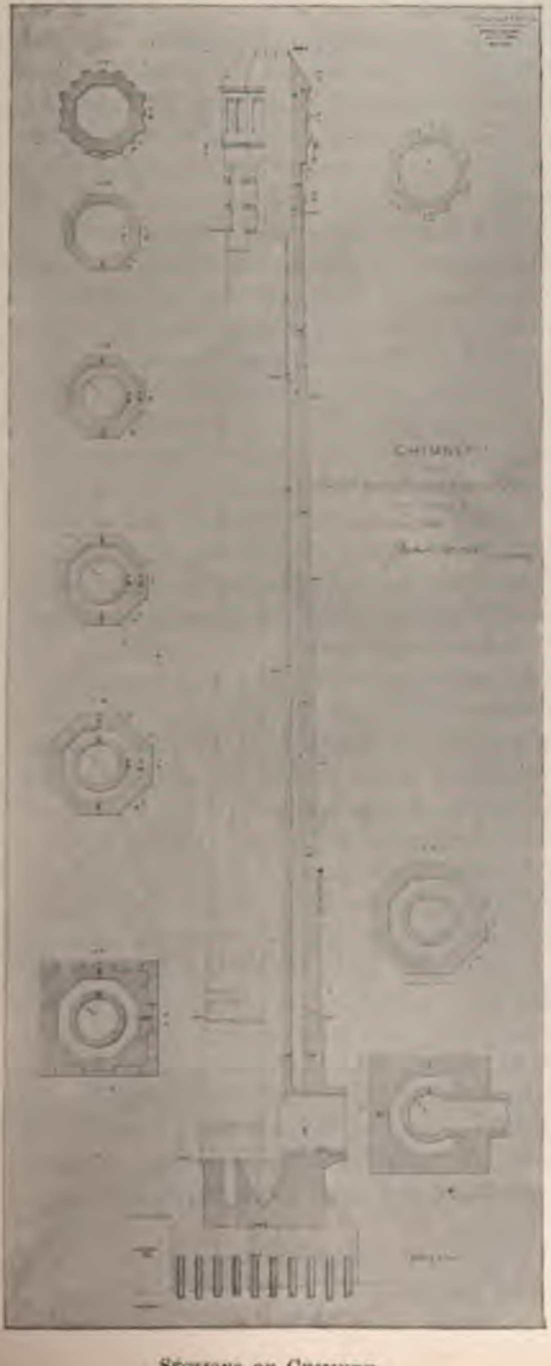
Concrete Foundation Plastered.

The cement was furnished by the city and comprised several brands, all being foreign brands, except the last engine piers, which were of Atlas cement. The concrete was machine mixed, the mixer being of the continuous type, with revolving arms. No stone were allowed to be used in the concrete greater than 2 inches in any dimension. The average quantity of concrete resulting was .73 of a cu. yd. or 19.71 cu. ft. per bbl. of cement. The specifications called for a ⅜-inch coat of Portland cement plaster upon all exposed surfaces. Because of this fact, every effort was made to have the concrete as rough as possible.

In the early part of the work pieces of lath and lagging were attached to the inner faces of the planking of the forms with the purpose of scoring the face so that the plaster would clinch the concrete structure. But by using unplaned spruce plank and being careful not to spade the softer concrete into the face and by "honey combing" the surface by pressing finer stone against the planking it was found that there was no necessity for additional roughness or scoring and therefore any means toward that end were abandoned. In applying the plaster the concrete was thoroughly wetted and brushed with wire brushes to remove any foreign or loose material, then the plaster applied in two coats, the first being "scratched" and allowed to only partially set before adding the smooth exterior finishing coat. Scarcely any of this plaster has separated from the concrete underbody, and none has fallen or flaked off of walls or piers. The accompanying two views show the south corridor as it was left after removal of concrete forms and the appearance of the same corridor after plastering. The lines which appear in the latter view are the divisions between the different areas as they were plastered. In this view can also be seen the ends of the 48-inch discharge pipes from pumps.

In contracting for the substructure only one item was bid for excavation and concrete, the two items being united. This makes it impossible to tell accurately the cost to the city of concrete masonry, but a careful comparison of different elements in the problem would seem to make the cost, including cement, from $8 to $9 per cu. yd. In this cost is also included the element of plaster.

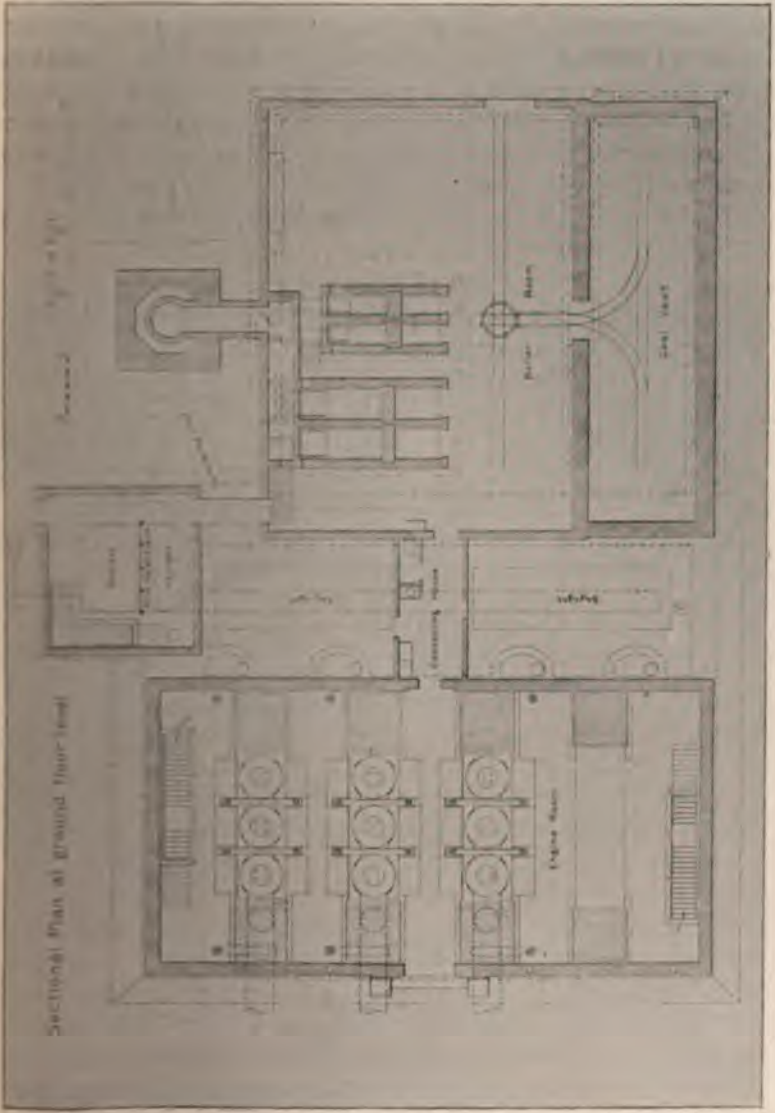
The superstructure of the pumping station consists of a brick



Sections of Chimney.

and limestone engine house 48x90. A combined boiler house and coal house 70x72, and a filth hoist house, separated from the other buildings, so as to prevent the passage of sewage fumes. The brick used is a smooth faced wire cut brick, having many of the qualities and presenting much of the appearance of pressed brick work. The interior faces of the buildings are of brick of the same character and manufacture as the exterior, but of a considerably lighter hue. The interior fittings are of oak. All the buildings have steel roofs, furnished by the Maryland Steel Co., and while of superior character, present no unusual features except in the manner of attaching the roof boarding. This was of 1-inch mill planed stock, which was fastened to the purlins by wrought nails which were clouted over the edge of the angle-iron purlins. In every case the roof boarding was laid diagonally and covered with 2 layers of Neponset roofing paper under the slating. This latter was of Munson slate. In the engine and filth hoist houses there is a ceiling of plaster at the elevation of the wall plates of trusses designed to lessen the height of the rooms so as to reduce the air space necessary to warm and also to prevent condensation of moisture, due to extreme variations in temperatures in these rooms, upon the truss members. Wire lathing is used, wired on the under side of ceiling purlins upon the lower chords of trusses.

The roof of the coal house is of 15" steel I beams between which are sprung 8" brick arches, the whole covered with concrete and having upon that a 2-inch coat of asphalt. This roof is parapeted and is connected with the roadway at the same elevation, 65 feet away, by a wooden bridge, so that coal can be brought and dumped through the manhole openings in the roof, into the vault below. The chimney is of the same general character as the buildings. It is 151.21 feet high, 16 feet square at the base and after developing into an octagonal form with recessed panels, tapers to a panelled head. It is founded on 100 piles driven to refusal. The earth was removed from around their heads and they were surrounded and covered with a base of Portland cement concrete. It has a flue 5 feet 6 inches in diameter. The lining of the flue is Barrington brick, of the same manufacture as the outer and inner faces of the buildings, but which



Sectional Plan at ground floor level

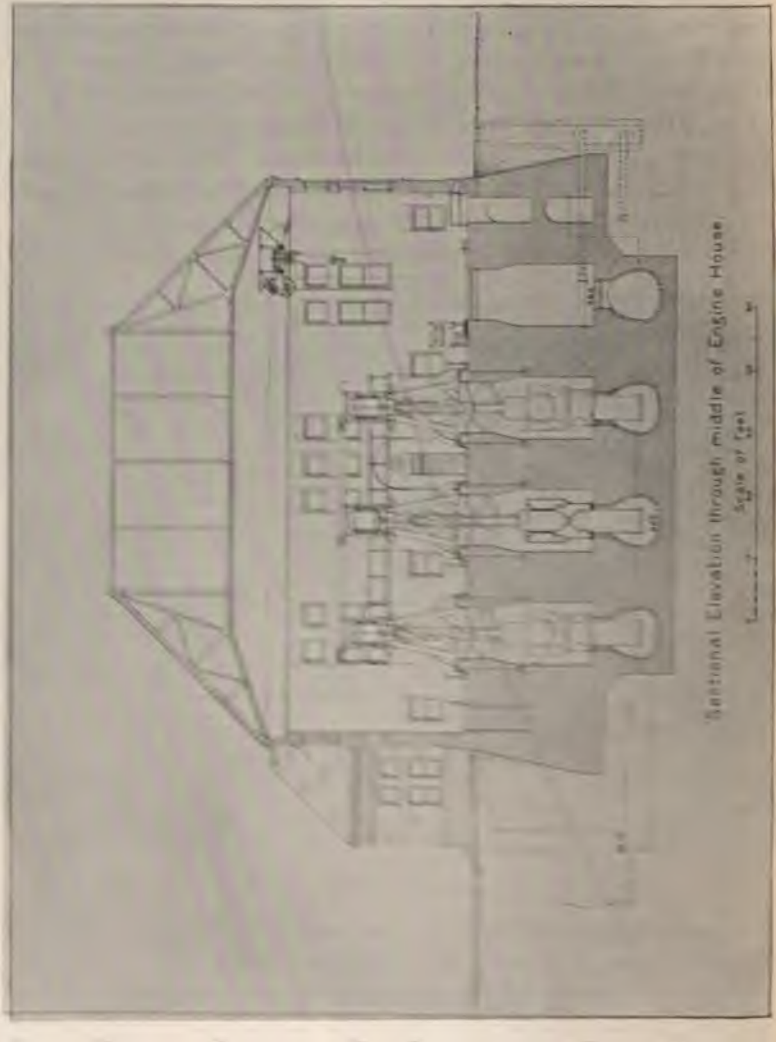
had been partially vitrified. In constructing the chimney ladders and iron steps were left in the space between flue and shell so as to permit passage, and at regular intervals brass tubes with screw caps were inserted in the core wall, so as to permit future study of flue temperatures and pressures. The chimney is surmounted by an octagonal cast iron cap 5 feet 10 inches high. No precautions were taken against lightning.

The entire power plant for the pumping of the sewage was furnished by the Holly Manufacturing Co. of Lockport, N. Y. The boilers are in two batteries of two units each. Each of the larger units is of 120 horse power capacity and each of the smaller of 80, giving a total horse power of 400. The boilers are of Babcock & Wilcox make. The boiler room is long enough to permit installing an additional battery of 240 horse power. It was also made wide enough to enable a tube to be inserted or removed without trouble. As can be seen the boilers are hand fed, as is the cheapest and best method in a plant of this size where one man both day and night can not only easily fire, but care for the water in the boilers. The coal is brought from coal vault and ashes removed from boilers by means of a C. W. Hunt Co. car and railway, the rails of which are flush with floor of boiler room. The coal is dumped through roof of coal vault and after being loaded into car is weighed on a platform scale between coal vault and turntable, the weighing beams of which are situated several feet from platform, the weight being transferred to the point of measurement by means of twister bar and heads. Back of the boilers is located a small economizer of the Green pattern of 48 tubes capacity. While not large in size, the work of boilers and economizer is very effective, the gases being sent to shaft during regular running from 300° to 400° Fahr. The boilers discharge their gases downward beneath the floor, and by a system of dampers and ducts it is possible to use any boiler or battery in connection with economizer or discharge directly into stack. At the entrance of the flue is hung a large damper, operated by a Stillman automatic damper regulator by means of which the pressure is maintained at 120 lbs. Only one main steam line is used, 8 inches in diameter, which is broken just before leaving the boiler room to introduce a simple separator which discharges the water, which is recovered back into the feed line. The feed water is composed of a mixture of Pawtuxet (or city water) and the condensation from jackets and reheaters. This is passed through an exhaust heater in the line of the exhaust pipe from the low pressure cylinder, and then through the economizer before entering boilers. It was intended to use the entire water of condensation, and when started the plant was so run, but the oil which was used in cylinder lubrication was carried over in great quantities, resulting in the burning out of a large number of tubes, and consequently the returns from condenser into hot well were disconnected from the feed system and the water discharged overboard.

BOILER ROOM.

A unique feature of the boiler room is that the walls of building and of boiler and economizer are all of the same smooth, light red brick, presenting a uniform and pleasing impression, and giving an atmosphere of harmony to the whole interior.

The pumps consist of 3, three cylinder—direct connected Holly pumps with a capacity of 32,000,000 gallons per 24 hours, at a piston speed of 200 feet per minute. They have attained in ser-



Sectional Elevation through middle of Engine House

Scale of Feet

vide, so far, a maximum capacity of 44,000,000 gallons. The suction pipe of each pump is 48" in diameter, and the discharge pipe into sewer of the same. The plungers are 42 inches in diameter and have a stroke of 5 feet and are single acting. The valves are circular rubber disc valves, seating on a Tobin bronze ring

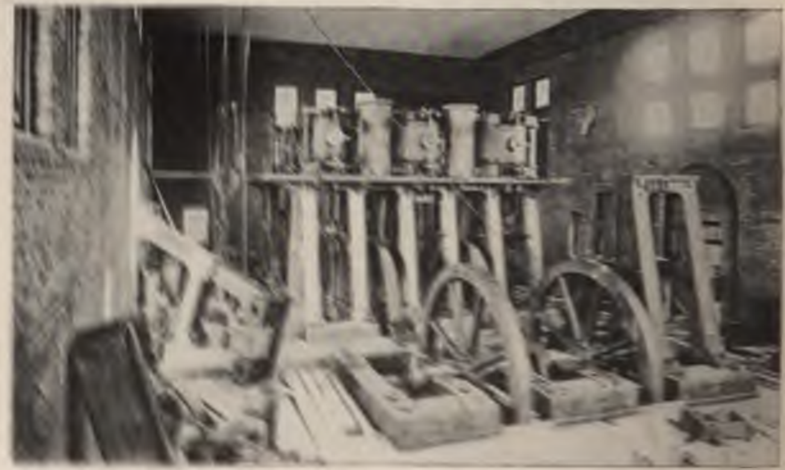
5½ inches in diameter. There are 72 of these openings in each suction and discharge set arranged in three inclined tiers, and provided with a Tobin bronze spring to aid in reseating, which were tested for an average tension of 18 lbs. for the mean opening. These springs were found to wear out very rapidly in use, especially in the upper tier of the suction half, and these have been replaced by cast iron discs, of weight sufficient to produce the same ease in closing as was secured by the use of springs. Another advantage in the use of the iron weight was that it did not collect the waste in such great quantities as did the springs, and thus gave a freer opening at all times.

A few points in which the pump portions of these engines are unique may be stated. They may be primed and washed without the use of anything other than the condensing water. The ordinary height of ground water is 5 feet above the top of the discharge chamber of pumps. By a system of underdrains beneath the overhanging walls of engine house this water is led into the system supplying water for condensation. This is piped to the discharge chamber of the low pressure pump, from whence it flows throughout the entire discharge system, and by opening the "bleeders" into the suction chambers, they may likewise be filled, thus priming the pumps and making it possible to start immediately with a full pump. By a system of "bleeders" from the suction chambers into the pump well, it is possible to convey the sewage retained in pumps when they are shut down, into the well, and then wash out the chambers with this same condensing water, thus making it cleaner and better to enter the pumps for inspection and repairs.

The water for condensing can be obtained from three sources. Being in close proximity to the waters of the Providence River a 24-inch circular brick condenser intake was built out into the river at an elevation 10 feet below mean high tide. A system of 6 and 8-inch underdrains surrounds the pumping station, supplying a large quantity of ground water of a very low temperature. The condensers are also connected with the city water mains. The discharge from the condensers, together with the condensation from the cylinders and reheaters and the overflow from the hot wells are trapped into the pump well and pumped up with the sewage. The condensers are of the surface type.

There are 3, inverted cylinder, triple expansion engines with improved Corliss valve gear. Space has been provided for a fourth, and plate pocket holes and pipes for foundation bolts have been left, thus making the installation thereof comparatively simple and inexpensive. The opening over well is now simply spanned by I beams and brick arches.

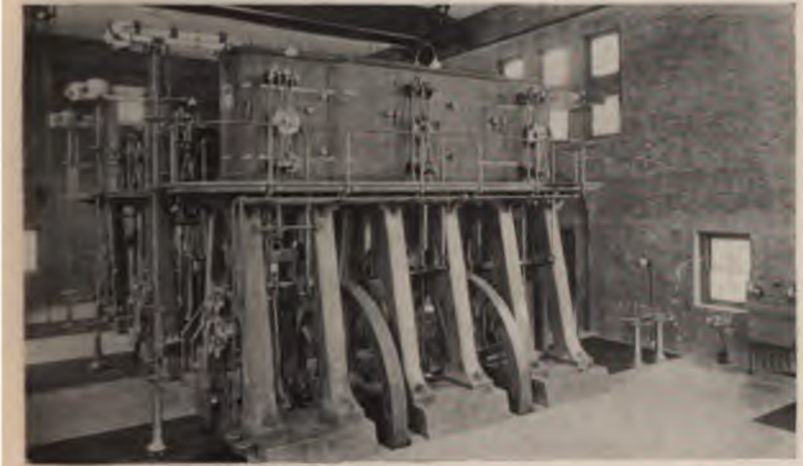
The cylinders are steam jacketed and have the valves in the heads. Holmes metallic packing is used for piston rods and



Engines Partially Constructed.

part of the valve stems. Between the cylinders are placed reheaters, separated from the cylinders by corrugated copper expansion joints. The point of cut off in intermediate and low pressure cylinders is regulated by hand, being usually about 1-3 stroke. That of high pressure is by a small governor which is belted for two speeds, and is also capable of hand regulation if desired. The view of the engines as partially constructed gives a very good idea of their several parts as also the fact that the station is provided with a travelling crane. By means of this the material was put in place very cheaply and expeditiously, dispensing entirely with the use of blocking and staging. This crane is of 10 tons ordinary—15 tons maximum capacity, and is entirely operated by hand. It was furnished by the Maryland Steel Co.

Two features in connection with the engines may be interesting. The steam valves between the 8-inch steam main and the 5-inch steam supply to each engine are easily operated by sprocket chains, and there are no galleries required to reach valves for shutting or opening. The other feature is that all valves of nearly every character are on the main floor of engine room and the engineer can operate valves and pumps without having to run down stairs.



FINISHED ENGINE.

The buildings are lighted by electricity, brought into the building and circuited to different parts of the building and to each engine at a switchboard located in the engine room. The wires are carried in iron armored conduits, so as to be free from influence of moisture and are located on the pump floor and brought up from there to the point of lighting.

The entire plant represents an expenditure of slightly over $200,000, divided roughly as follows:

Substructure	$ 50,000
Superstructure and chimney	50,000
Boiler and pumping plant	100,000
Total	$200,000

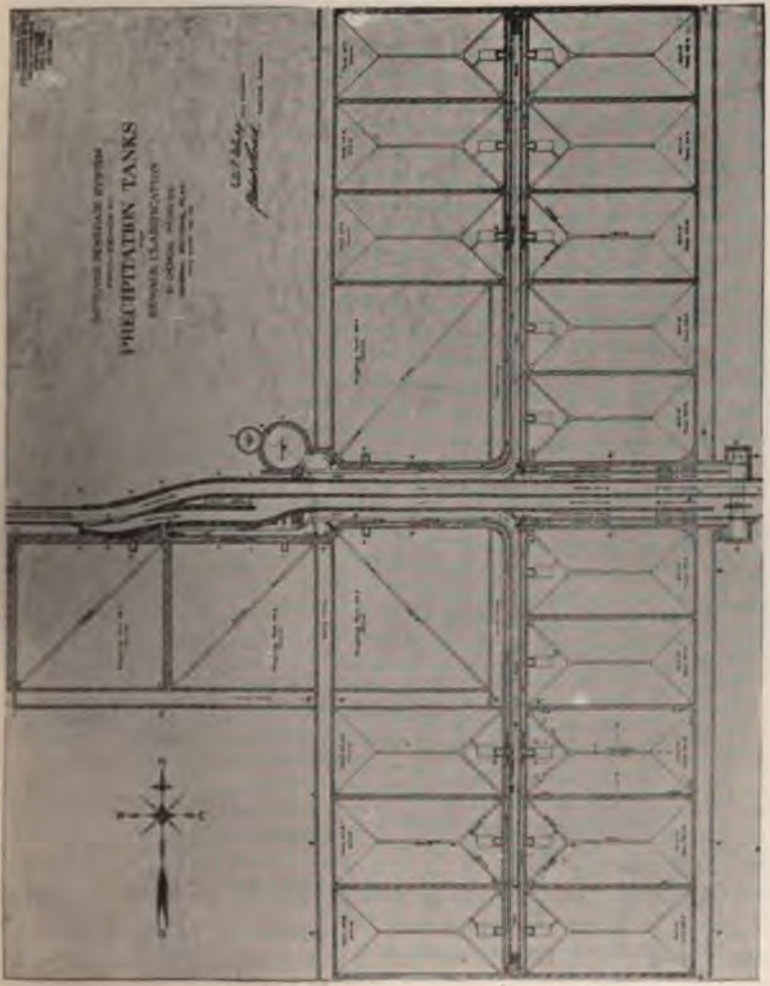
Some 3,000 feet below the pumping station are situated the Precipitation Tanks for the clarification of the sewage before discharge into the waters of the Providence River at Field's Point.

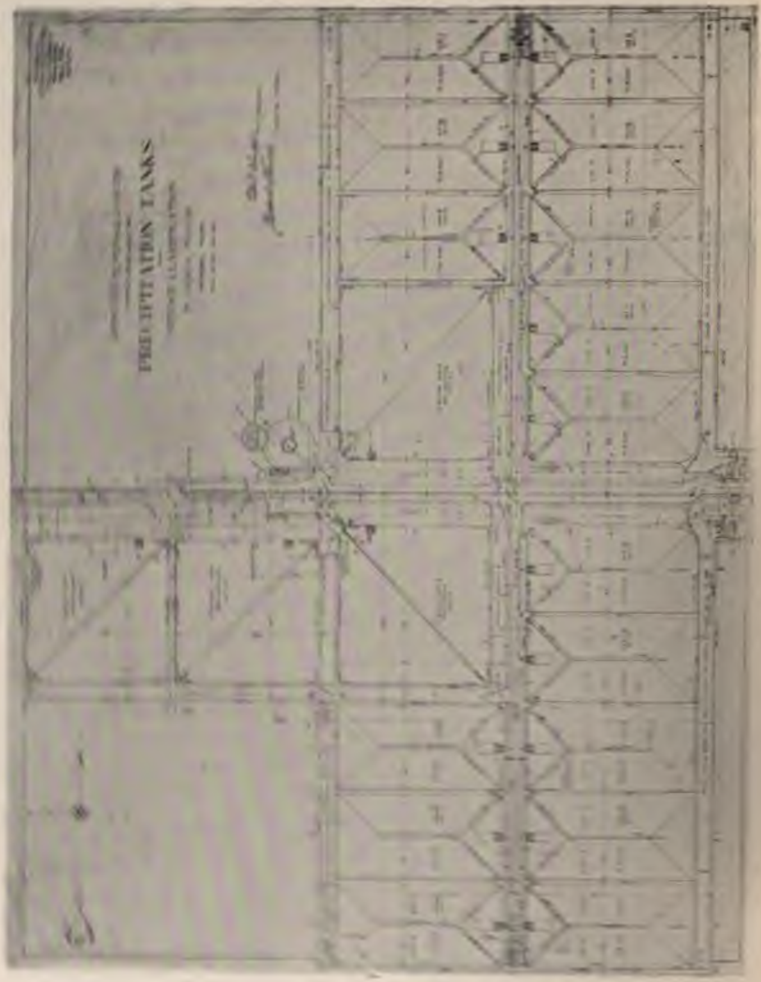
Engine House and Grounds.

These tanks are 20 in number and cover an area of 4.73 acres. They are divided in 4 roughing tanks, two of which are 100 feet square, one 105x112 and one 105x122, and 16 finishing tanks which are all of the same size, viz., 60x115. They are constructed entirely of concrete, no brick or stone masonry whatever entering into the construction of the tanks proper.

From the plan of the tanks here shown can be gained a very good idea of their form and arrangement.

Just before reaching the tanks the sewage passes through a mixing channel, the chemicals being introduced 100 feet above its upper end. This is an open semi-circular channel 16 feet in diameter, having sixteen 4-inch bluestone baffle plates, staggered 6 ft. apart throughout its length, and in which each stone projects 6 inches beyond the central line. The grade on this channelway is double that of the force main sewer supplying it, this increase





tending to produce a greater velocity, and consequently better mixture. After passing the mixing channel the sewage enters the roughing tanks.

The office of the roughing tank is threefold. There is much variation in the concentration of the sewage flowing at different hours in the 24. That which flows at night is very dilute, while that which comes to the tanks during the busier hours of the day, from 9 to 4, is very condensed. In Providence a large percentage of the refractory matter to clarify out of the sewage is the result of wool washing, and of dyeing and bleaching in the cotton and woolen mills. Of course this is flowing mostly in the middle of the day. The roughing tank is thus used as an equalizer of the sewage flowing throughout the day and so, by retaining the more dilute sewage of the night flow to mix with the more concentrated sewage of the day and thus make a more regular sewage for treatment, resulting in a much more uniform as well as a much smaller amount of chemical, a better and more uniform effluent and a much reduced cost.

PRECIPITATION TANK SHOWING WEIR.

Again, as spoken of formerly, the sewage is generally very heavily charged with fine sand, the result of wool washing. This is largely augmented in time of storms by the sand and street detritus washed into the sewers, and there being no adequate provision for settlement, this will reach the precipitation tanks in greater or less quantities, and will be settled out in the roughing,

Precipitation Tank.

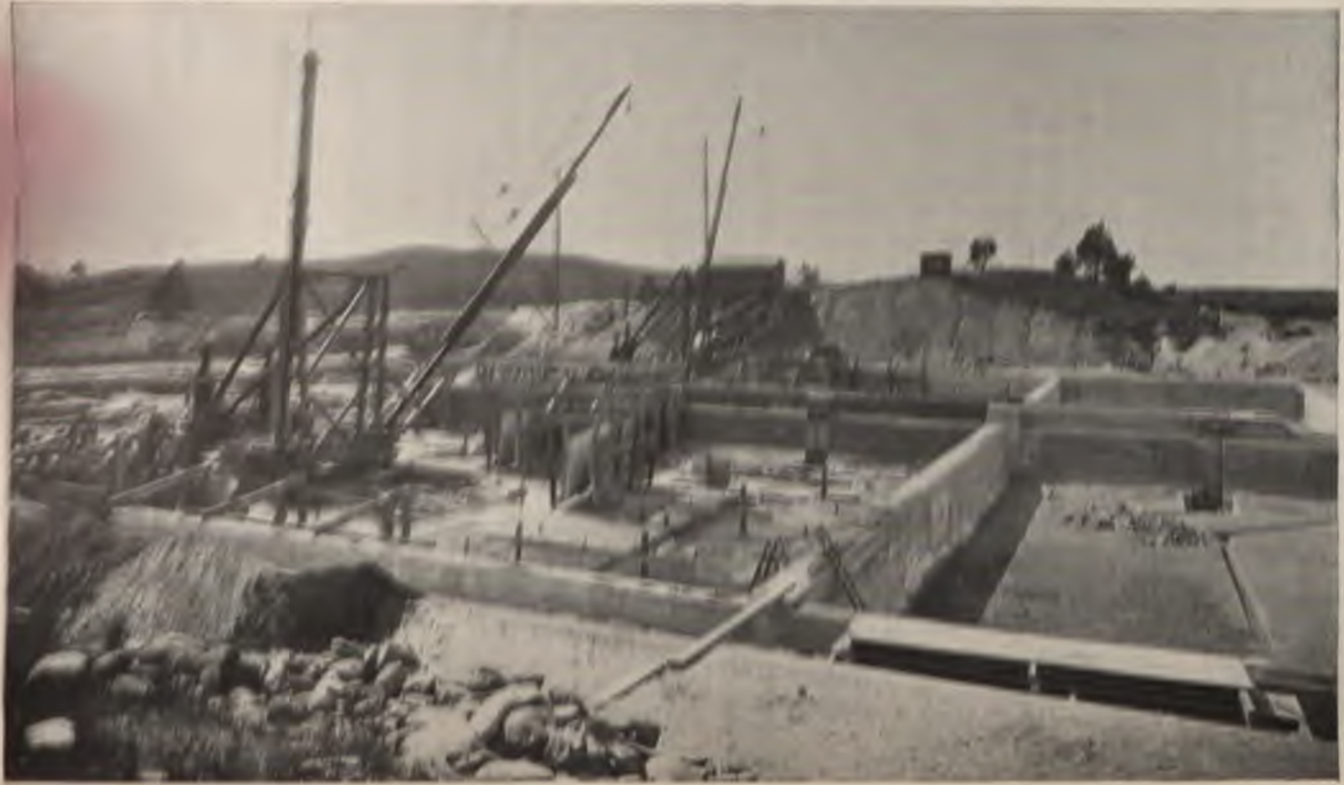
being aided thereto by the occlusive character of the initial part of precipitation.

The third office of the roughing tank is, that the first part of precipitation is very much more rapid than the secondary or final clarification, the process can be expedited and cheapened by allowing the large floculent first part to separate out, carrying with it such of the finer matters as they can occluse and leaving the slower process of complete subsidence to take place in smaller tanks where the process can be managed with greater nicety.

In leaving the roughing tanks the partially clarified sewage flows over a long weir and along a channel with a very flat slope and enters the finishing tanks, which are arranged symmetrically on either side of the central supply channel, and then flows lengthwise of each tank, discharging as effluent over a weir at the end into a channel which conveys the effluent to effluent wells at the centre of the eastern side of tanks, where it enters the outfall sewer either through a wheel pit or is by passed directly to the sewer and discharged.

The sludge remaining in the tanks, after decanting off the effluent below crest of weir, is forced through channels in the floor of tanks and then in corridors running through central lines of tanks, both from north to south and from east to west, finally reaching a sludge well, where it is screened of all solids, and from which it flows into an ejector well adjacent, in which are located two Shone pneumatic ejectors, which force the sludge by alternate action into 5 sludge reservoirs (not shown in plan), located in N. W. angle of tanks. Here the entrained water in the sludge is allowed to partially separate, after which the sludge is forced pneumatically into Johnson filter presses, while the supernatant liquid is conveyed back to the main supply channel to tanks to be retreated with the sewage.

In constructing the tanks few problems of great difficulty were encountered. The location selected for the site was a glacial morain, fashioned by wind and weather into rounded, verdureless drumlins. In one of the larger of the hollows the tanks were placed. The central portion thereof was a swamp filled with the accumulationed peat and vegetable matter of centuries. This was entirely cleaned and then filled with gravel, the latter being



TANKS PARTIALLY COMPLETED.

allowed to be dumped in water only, and a resulting material was produced more resistant than the surrounding original soil. The larger part of the area was excavated some 9 years previous to beginning constructing the tanks and so the excavation necessary to bring them to finished grade was in most instances comparatively shallow. This was made by a steam shovel discharging into cars. All sand of a superior character and graded in size, well adapted for the future concrete work, was found at site of work.

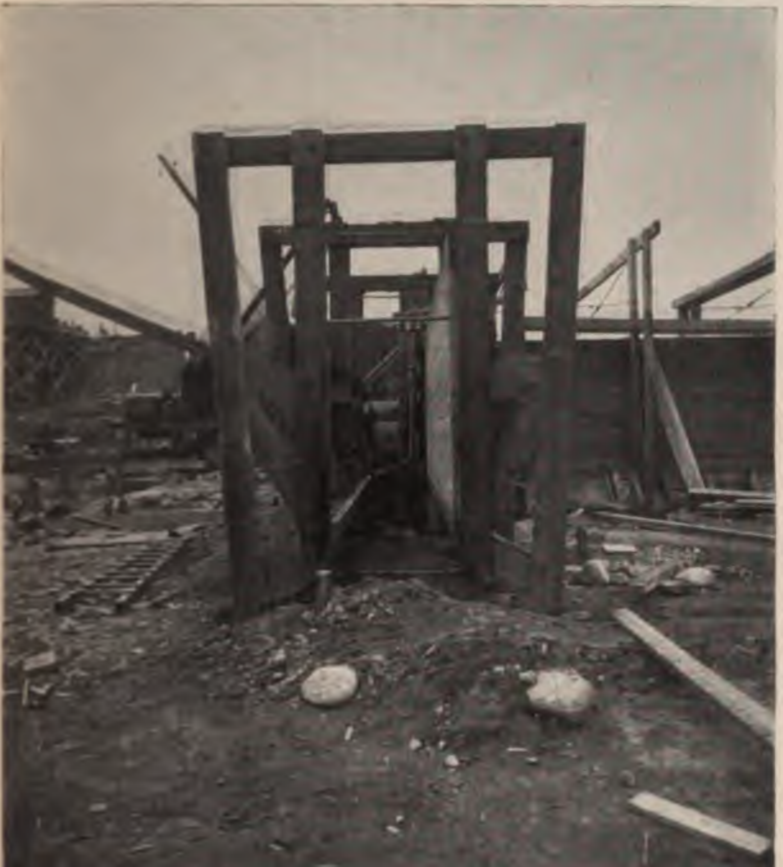
The entire area was surrounded by a system of underdrains, and throughout, underdrains were laid beneath the sludge drains and gutters, they being the lowest part of the system in order to keep a dry surface on which to concrete, and after the tanks were finished they were filled with cement grout under pressure, this grout being composed of fine sand, Portland cement and a small proportion of quick lime to give it fluidity.

There were some 50,000 cu. yds. of earth excavation, and 25,000 cu. yds. of concrete masonry included in this work. The concrete was of the character called "cyclopean" or rubble concrete. It was all machine mixed, the local topography being of such a character that all the ingredients could be hauled to the top of the slope on the western side of the tanks where they were dumped into hoppers and were fed by gravity into chutes, in which were partitions, so placed that the volume between represented the quantity of each material necessary to produce the primary mixture of 1 cement, 2½ sand and 5 gravel. By throwing a lever connected with the throats of the chutes they could be thrown in rotation, delivering their contents into the hopper of a Cockburn, Barrow Co.'s continuous mixer of the rectangular type. The concrete was discharged into buckets and transported to points where it could be handled by one of the booms of 2 double platform derricks. These booms were 75 feet long and the extreme width of the tanks being 274 feet the 4 would thus cover the entire width of tanks.

The feature of the concrete of greatest value and moment was in the use of rubble stone from any size above 2 inches to ½ to ¾ of a cubic yard. In placing the concrete the following method was pursued. A bed of concrete of a plastic jelly-like consistency was placed between the forms, mixed soft enough to quake easily, but not so as to have water more than come to surface without working it, of a depth of from 6 inches to a foot. Into this plastic mass was thrown the rubble stone previously spoken of, being forced into the soft concrete to as great a depth as possible. It was only required that the stone should be of approved quality, cleaned so as to be free from earth and washed or wetted so as to bond and unite better with the surrounding concrete. It was required that none of these larger stones should touch each other and none should approach nearer the face than 2 inches. The larger aggregates measuring in the vicinity of ½ cubic yard were either placed before and the concrete filled around, or else were deposited in the concrete by the use of the derricks. These larger aggregates were always put into the bottom of the walls in order to assist in lowering the centre of gravity as much as possible. Again they were only put into the thickest walls to the larger size. By the use of these larger aggregates the quantity of concrete per barrel of cement was largely increased, results of $1\frac{1}{10}$ to 1½ cu. yds. per barrel being secured. The work was by contract; the city furnishing the cement. The total cost per cubic yard of concrete, including cement, was less than $5 per cubic yard.

In the specifications, while a smooth and satisfactory surface finish was stipulated, it was neither required nor desired that they should be plastered, there being great doubt as to the permanency of a plastered surface exposed to the elements. A smooth and satisfactory surface was secured by spading the concrete next the boarding very thoroughly so as to force the stone back from forms and permit only the finer materials to reach the surface. Upon the removal of the forms this was washed with 3 coats of very thin cement wash, applied with a whitewash brush.

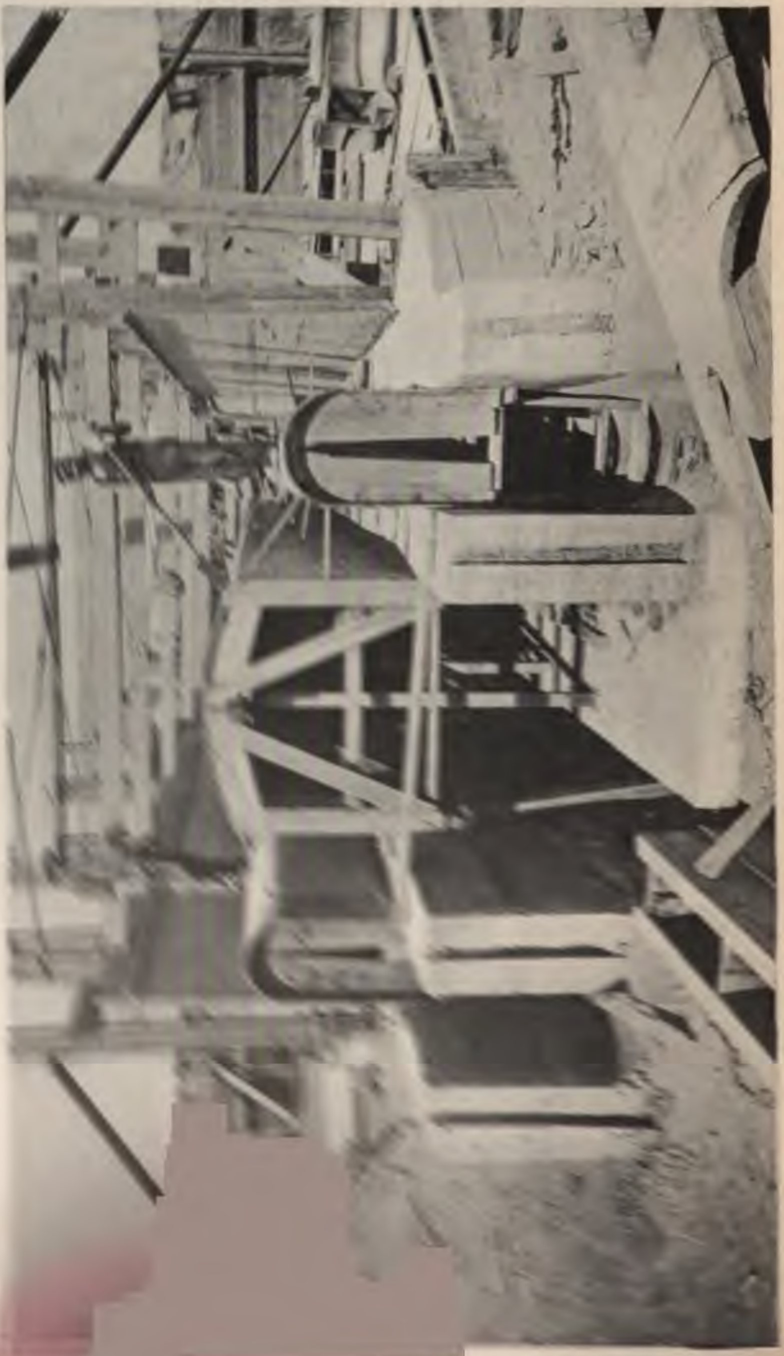
The forms were of a superior character, being of southern pine, very smooth. Their special character was that they were all built so as to either leave walls or channels when struck or collapsible so as to free themselves immediately by shutting up. No tie rods of iron or timber and no struts or braces were left in any finished work in order to support or stay forms during construction.



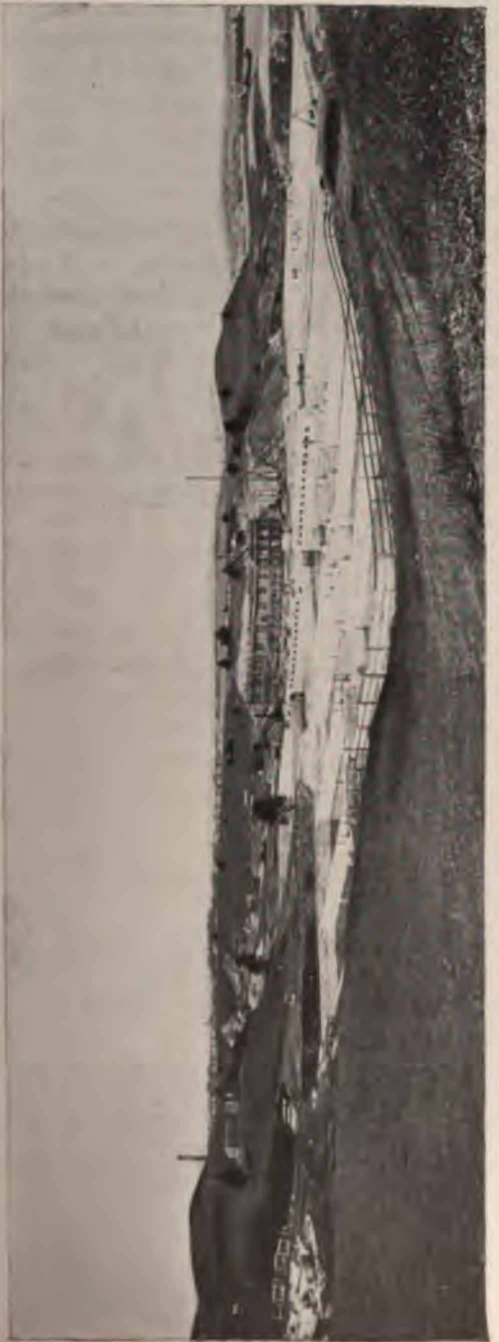
DIVISION WALL FORM.

From the accompanying view of the forms for division wall can be gained a good idea of the forms of the larger kind. These forms were easily raised entirely or by disconnecting their upper timbers, they fell back slightly from wall and so were removed without disturbing the smooth outer skin of the wall.

The sludge corridor forms and forms of effluent draw off channels were built so that they should be ½ the height of the passage or channel, so that in one case they could be elevated and in the



FORMS OVER SLUDGE CORRIDOR.



General View of Precipitation Tanks.

other shut up, removed and reversed to construct the upper half. In the accompanying view this can easily be seen, as well as the special construction by means of which the forms were collapsed.

In this latter view can also be seen the dove-tailing by means of which vertical joints between two different pieces of work were connected. A three-piece triangular dovetail form being inserted in the middle of all vertical ends and horizontally in all arches, so that the new concrete could lock into the older and bind them together. There were several other interesting features in the concrete construction, but time forbids their relation. The last views showing the work in larger style will possibly give a better idea of form and detail as well as character and appearance than can be given in words. By these larger views, as well as by the panoramic view, it will be seen that the floors of tanks were first protected by earth and later by filling with water from the action of the sun and of the elements. While the concrete parts of the tanks are completed, much remains to be done in the way of gates, machinery and buildings for the chemical and pressing departments.

NOTES ON ENGINEERING WORK AT HOLYOKE, MASS.

BY GEO. E. MANNING, NEW LONDON, CONN.

Holyoke is on the Connecticut River, 84 miles from its mouth. The river above Holyoke is about 300 miles long and drains an area of about 8,000 square miles. Its source in the northern part of New Hampshire is at an elevation of 1,589 feet above Long Island Sound at its mouth. After it reaches Bellow's Falls, Vt., 86 miles above Holyoke, where there is a fall of 52 ft., the remaining descent is made chiefly at three points, a fall of 75 ft. at Turner's Falls, Mass., 36 miles above Holyoke, one of 30 ft. at Enfield, Conn., 16 miles below Holyoke, and Hadley Falls, the one at Holyoke, where 59.9 ft. is utilized. The effect of the dam at Holyoke with 2 ft. flash boards extends for nearly 20 miles upstream, where it is no longer noticeable.

LOCKS AND CANALS FOR RIVER NAVIGATION.

The earliest record of work at the Hadley Falls of the Connecticut River, which required the services of an engineer, was in 1792, when a corporation. "The Proprietors of the Locks and Canals on the Connecticut River," with Benjamin Prescott of Northampton as engineer constructed a canal for navigation purposes on the South Hadley side, about 2½ miles long, which opened into the river just above a wing dam projecting obliquely outward from a point about where the end of the timber dam of 1849 was located. In 1797 the tolls amounted to about $5,000, in 1815 to $11,000, in 1817 $15,000, in 1833 $20,000. But by 1845 railroads had been built, against which the crude navigation of the river afforded by the locks and canals could not compete, and their value was destroyed.

On the Holyoke side, a cotton mill of 4,000 spindles, which derived its power from a wing dam, had been built in 1831, and, with the exception of a grist mill, was the first and only utilization of the power of the river.

THE HADLEY FALLS CO. AND DAM OF 1848.

In 1847 a group of men, who had purchased about all of the land on which the city of Holyoke is now built, obtained a charter, creating the Hadley Falls Co. In 1848 the rights and real estate of the Proprietors of the Locks and Canals were conveyed to the company, a temporary dam across the river was constructed and the work on the canals begun. On Nov. 16, 1848, the openings left in the dam for the flow of the river were closed. In about five hours, when the water had risen to within two or three feet of the top, all but about 75 ft. at one end and 150 ft. at the other broke loose and rolled over down the river. The design of this dam is not known, but from tradition it is supposed that it was framed, timbers being used as struts to support the plank sheathing. The principal cause of its failure was thought to be that the upstream face was given a too steep slope. It seems probable that it was not bolted down to the bed rock sufficiently strong at the upstream point or enough protection given at this point to prevent the water from running under it.

DAM OF 1849.

Plans were then made for a more substantial and what was expected to be a permanent structure. This dam was completed during the next summer—1849. Its length is 1,017 ft., its height 30 ft. At the two ends are abutments of heavy cement masonry. Between these abutments it is composed of a crib work of heavy timbers, the smallest being 12-in. square, which are built up in such a way as to support on the upper side a sheathing of plank inclined at an angle of [illegible] to the water surface. The timbers which cross the river transversely are supported by other timbers at right angles with them, which are arranged in 170 sections, 6 ft. apart. The ends of these timbers parallel with the course of the river are bolted to the solid bed rock with 1¼-in. iron bolts, of which there are nearly 3,000. Four million feet of timber were used in this structure. The upstream point of the dam was protected by a mass of concrete. As the timber work was built up the whole foundation, 90 ft. in width and all open spaces, were packed solidly with stone to the height of 10 ft. The sheathing of the dam was made to a thickness of 18 inches, 3 layers of plank, each of 6 inches, all treenailed and spiked together. The crest was protected with sheets of boiler plate, placed side by side and extending the whole length of the dam. The graveling in the bed of the river begins 70 ft. above the dam, and is continued over 30 ft. of its sloping surface, which is 92 ft. from base to crest.

During construction, 16ft.x18ft. openings, of which there were 46 when the work was finished, were left for the flow of the river. These were provided with gates, which were closed Oct. 22, 1849, alternately, one-half of them all at the same signal and then the remaining half at a second signal.

It was considered that a considerable leakage was a benefit in keeping the timbers wet and to protect them from decaying. This idea has proved to be erroneous, so far as the upper parts are concerned.

The action of the wind upon the unbroken sheet of water 1,000 ft. long and 30 ft. high, caused remarkable vibrations in the air which rattled the windows in Springfield, eight miles away, and it was even claimed that its effect was noticed at Hartford, 34 miles away.

It appears that flash boards were used for portions of the way across to break up the solid stream, admit the air behind it and prevent this. The ledge rock which forms the bed of the river is the common red sandstone of the Connecticut Valley. It is composed of layers which dip at an angle of about 30°, the direction of the dip being almost directly downstream from the dam or such that the force of the overflowing water has the worst effect in displacing it. The pounding action of logs and ice running over the dam in the spring freshets was severe and perhaps a principal agent of erosion.

As there was nothing to give direction to the current away from the dam, the logs and ice were often thrown against it. After a time it appeared that logs must at times have been caught end-wise between the timbers of the face of the dam and the water falling on the free end acted as upon a lever in prying out timbers.

Nothing was done to the dam for 19 years, till 1868, when an examination showed that the ledge was eroded in front of it to a depth of 20 to 25 ft., and the dam was undermined in places. There were depressions in the line of the crest.

THE APRON.

During the years 1868, 1869 and 1870 the apron downstream from the dam of 1849 was built. It is composed of round logs laid up 6 ft. apart in crib work of square sections. The irregular shape of the bottom was determined by the use of the sounding rod. The lower courses were built afloat, of a shape to fit the contours of the bottom where they were to be placed. Sections about 130 ft. long were sunk at one time by loading them with stone. Above the water level it was built up as a continuous structure. All openings were filled to the top with stone, and an outside covering of hardwood plank 6 in. thick put on. The volume of the apron is larger than that of the original dam. S. S. Chase was the company's engineer then. The erosion of the river bed continued, and again reached a depth of 25 to 30 ft. in places.

BREAKS IN THE SHEATHING.

In 1870 a break occurred in the plank covering on the water side of the dam. In the next five years there were several more breaks, and in 1885 they became many, large and difficult to patch. In one case, in July, 1885, the whirlpool formed in the water going down through a break had a central air hole about 2 ft. in diameter and 10 ft. deep. In the repair of these, cofferdams were used which were made on shore to fit the angle of the dam, floated out, and sunk so as to enclose the broken place, when the water would run out through the hole and leave the place cleared for repairs. At last the old sheathing became so badly decayed that it was impossible to sink the cofferdams without breaking through new places.

In 1885, under Mr. Clemens Herschel as engineer, the upper portions of the dam were rebuilt by the use of cofferdams, taking it in sections of 100 feet at a time. The sheathing for 20 ft. down the slope from the crest was found to be badly decayed, and many of the upper timbers had to be replaced.

A row of 3-in. sheet piling was placed close between the timbers of each section from one abutment to the other and reaching down 25 ft. to 28 ft. below the crest of the dam. Back of this all open places in the dam were filled with gravel as closely as possible by the liberal use of water. It was expected that the sheet piling would hold the gravel in place. From the examinations that could be made at that time it appeared that a large portion of the loose rock that had been placed in the dam had been washed out. And there was evidence later that the gravel filling of 1885 was all washed out in the course of a few years. By 1895, breaks in the new plank covering began to occur again. The constant leakage at that time was estimated to be equivalent to a loss of 800 theoretical horse power.

THE NEW STONE MASONRY DAM.

In 1891, surveys were begun for a new stone masonry dam. It was designed and has been constructed under Mr. Edward S. Waters, chief engineer of the Holyoke Water Power Co.

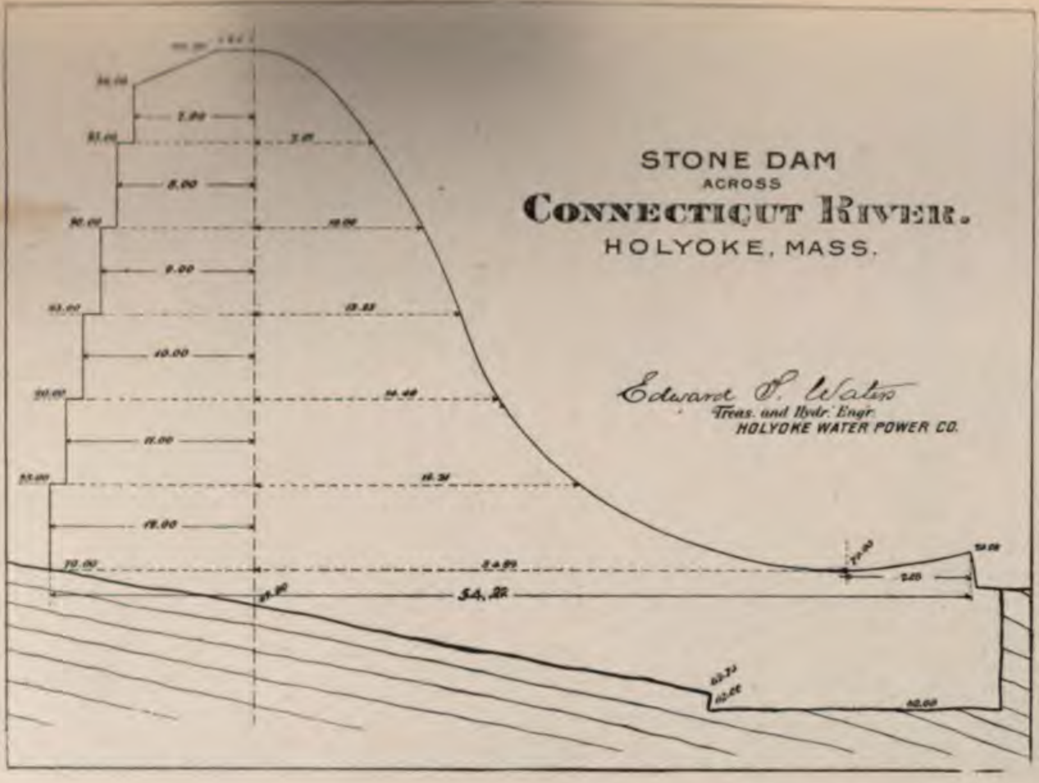
In the dry seasons of 1893, 1894, 1895 and 1896, when all the flow of the river was utilized, the necessary excavations were made by the Power Co. First, a channel was made about midway in the river to drain the site. A trench for the toe of the dam was made across the river, about 15 to 18 ft. in width, and about 8 ft. deep, except at two or three short places where the surface drops down to about 3 ft. above the bottom. The total quantity excavated was about 13,000 cu. yds.

The pool formed in the bed rock of the river by the action of the current was found to extend to a width in some places of 100 ft. downstream from the apron.

The crest line of the new dam was located at the South Hadley Falls end 112 ft. and at the Holyoke end 132 ft. below the edge of the apron, which is 50 ft. downstream from the crest of the old dam. Its elevation is the same as that of the original dam. The length of the rollway between abutments is 1,020 ft. The abutments are extensions of those of the old dam, and are built to a height of 12 ft. above the crest. In the original construction, this height was made 10 ft., which was overtopped by a freshet in April, 1862, since when the abutments and gate house construction have been raised 2 ft. The upstream side of the dam at the bottom is 12 ft. from the vertical plane of the crest line. In outline section the back side is built up 25 ft. in 5 steps, each 5 ft. high and 1 ft. wide, in order to afford support for cofferdams during construction. From this point there is a vertical rise of 3 ft., and then a slope to the top of 2 ft. vertical on 5 ft. horizontal. A width of 2 ft. on the upstream side of the crest line is flat. The face is an ogee. The upper part of the curve beginning at the

HOLYOKE DAM, OCTOBER 18, 1888.

crest is that of a parabola down to a point 20 ft. below the level of the crest, and 19.4 ft. out. From this point the lower portion is that of a cycloid. The parabola selected is the curve of freely falling water flowing 4 ft. deep over the crest of the dam. The water in falling the 30 ft. is brought forward 34.80 ft. The masonry is carried out downstream from this point 7.33 ft. and on an upward slope of 1 ft. The desired result of this shape being that the water shall flow away in a horizontal direction and not


STONE DAM
ACROSS
CONNECTICUT RIVER.
HOLYOKE, MASS.
Edward S. Waters
Treas. and Hydr. Engr.
HOLYOKE WATER POWER CO.
7.00
8.00
9.00
10.00
11.00
12.00
70.00
54.22

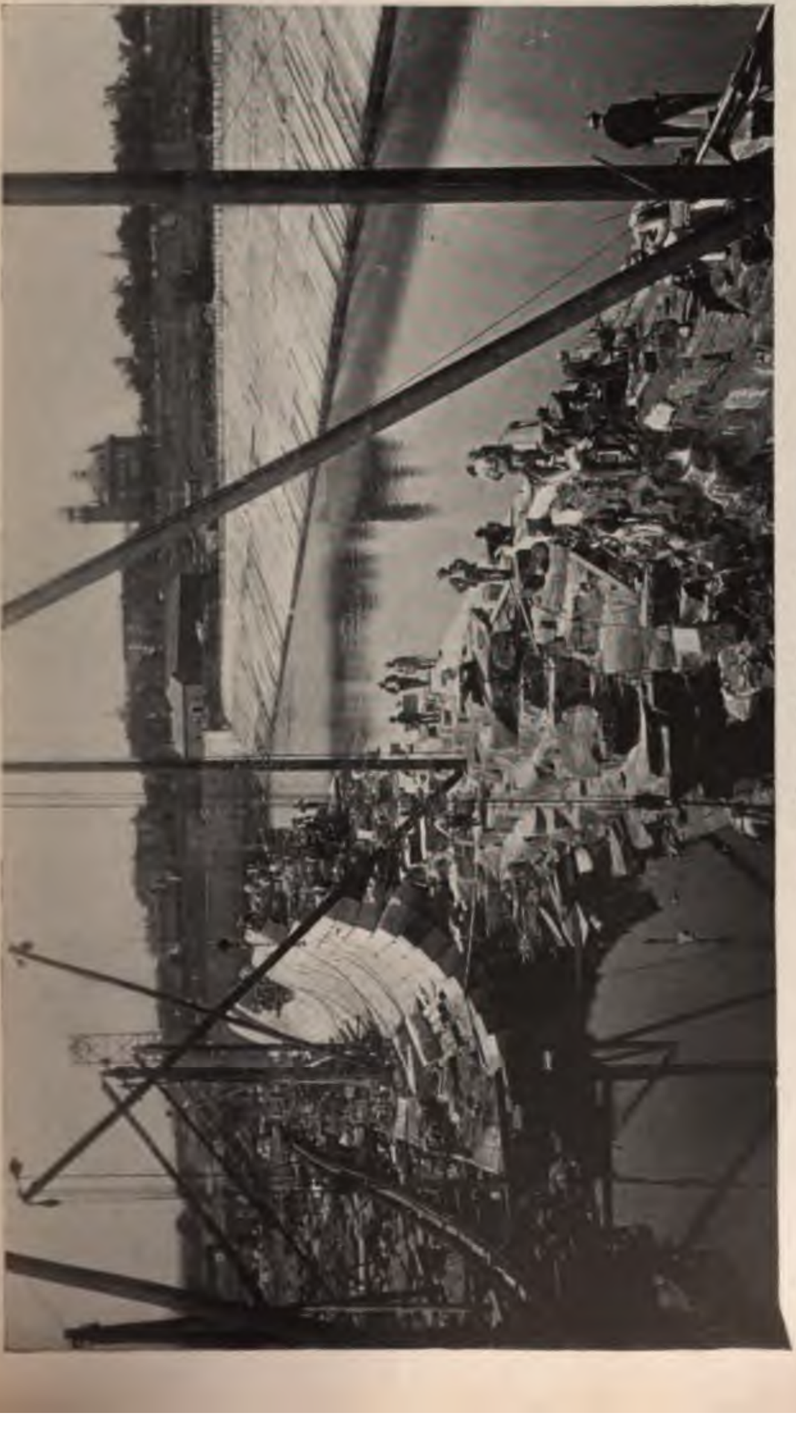
impinge against the easily broken rock of the river bed, nor on the other hand be thrown up to fall back upon it. The base of the dam is 54.22 ft. wide.

MATERIALS.

The rubble masonry of the core of the dam is brownstone quarried from the river below the dam and laid on its natural bed. The face is of granite, laid with ¼-in. joints; the back also of granite with ½-in. joints. The bonding in the courses of the face is made up out of one header to two stretchers. The joint between the two stretchers has a header below and a header above it. The larger part by far of each header stone was built back into the core. All the courses are 30-in. thick. Lengthwise of the courses the stretchers are 80-in. long, and the headers 40-in. long. The joints of the face are cut 40-in. deep, of the back and abutments 30-in. deep. The entire top of the dam down to a level 3 ft. below the crest, an area of 16,150 sq ft., is finished in 6 cut work, and the remainder of the exposed face is fine-pointed. Alpha brand of Portland cement was used for all parts of the work. The proportions used for mortar for rubble work were 1 of cement to 2 of sand; ⅞ of a barrel of cement were used per cubic yard. For concrete the proportions were 1 of cement, 2½ of sand and 5 parts of broken stone. For the joints of the face, 1 to 1 mortar was used. As a rule, it was used in the form of grout, the joints being too nearly vertical to permit the laying of the stone on a bed of mortar. When the grout was poured in a sword was run through the joint to make sure that every crevice was filled. For the top courses where all of the joints could not be reached in this way, a calking of oakum was placed around the outer edges, and the grout forced in by the means of a pump. The open spaces underneath the parts of the headers laid into the core were filled with 1 to 1 grout. When the mortar had settled out of the surplus water used in making it grout the process of filling was repeated.

Outside joints were raked out to 1-in. and pointed with neat cement.

In the toe of the dam no rubble work was used, but about 1½ ft. thick of concrete under the headers of the face courses. The



General View of Dam During Construction.

first course of face stone laid was the third from the toe, as the joints of this course are the nearest vertical. Between the toe of the dam and the ledge rock of the river bed the excavated trench was refilled with concrete.

All of the stones of the eight lower courses and of the top courses are bound together with 1½-in. in diameter galvanized round iron dowells or dogs. The dowells were 16-in. long and the dogs 16-in. out to out and were let into the stone 8 in. The dogs were countersunk beneath the face of the stone. All were completely enclosed with cement.

By the use of cofferdams, which were in many cases composed of a low pile of sand bags, water was kept out and in no instance has the laying of masonry under water been allowed. All stones in the face of the dam were levelled, and lined by instruments, as well as by spirit level and special templates for the batter. Each of the 23 courses in the face and top of the dam was designated by a letter. Each cut stone, when sent to the work bore a number, and a letter, which showed its place. All were cut according to drawings furnished. A bridge of large timbers rigidly placed near the centre and crosswise of the dam had carefully marked upon it the line of the vertical plane through each course, over which a transit could be set. Foresights in either direction, were obtained from targets painted on a horizontal board (of which the one at the Holyoke end can be seen on the abutment in the illustration of a section of the dam), which were accurately placed and lettered to indicate the lines of the several courses.

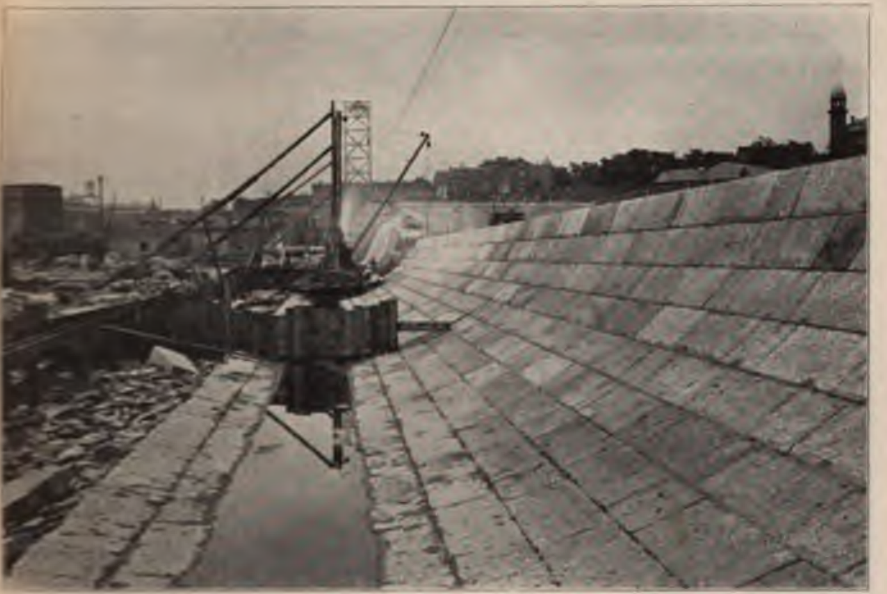
First-class material and workmanship in every way were specified, and by rigid inspection were obtained to a very unusual degree. The unfinished rubble work was severely tested, and showed its qualities by withstanding the force of the running ice in the spring freshets of the four years the work was under way. The dam may be considered as being as near a perfect example of masonry, probably, as it is possible to construct.

QUANTITIES.

The final estimates of quantities were, of concrete 1,595 cu. yds., of rubble masonry 34,439 cu. yds., of granite dimension masonry 13,122 cu. yds. Of the granite about 1,825 cu. yds. are in the upper courses, and 7,000 cu. yds. in the face of the dam.

The cost of masonry was $531,384.64. The cost of excavation for foundations is not included in this.

The contract for the construction was let in Feb., 1895. High water prevails in the river, so that no work can be done before July. The work was carried on for 5 seasons, till Jan. 5, 1900, when the last stone was set and the dam completed.

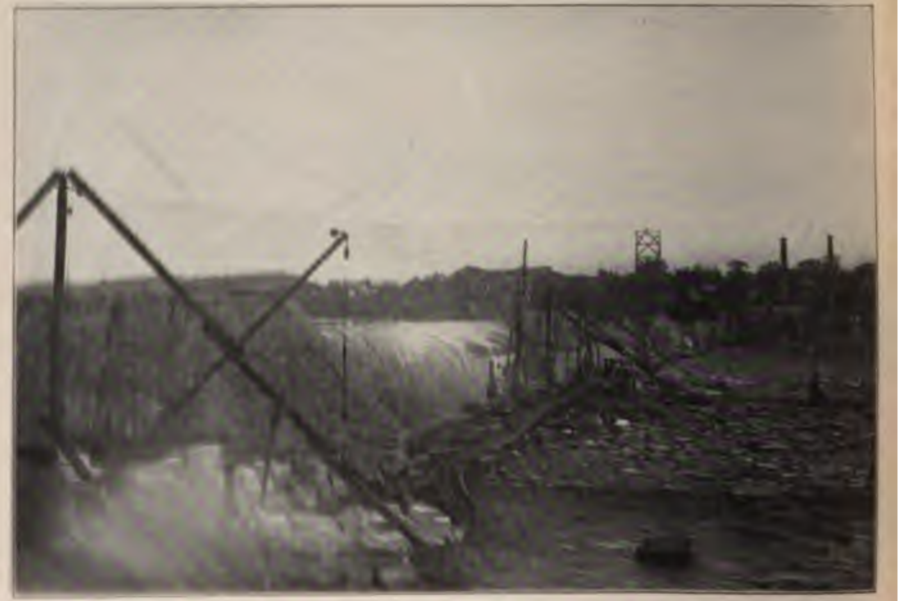


THE LOWEST PART OF THE OGEE FACE.
By Courtesy of "The Engineering Record."

There have been two contractors. The first was the Fruin-Bambrick Construction Co., and Henry S. Hopkins of St. Louis, Mo. The work was completed by Mr. Arthur McMullen of New York as contractor.

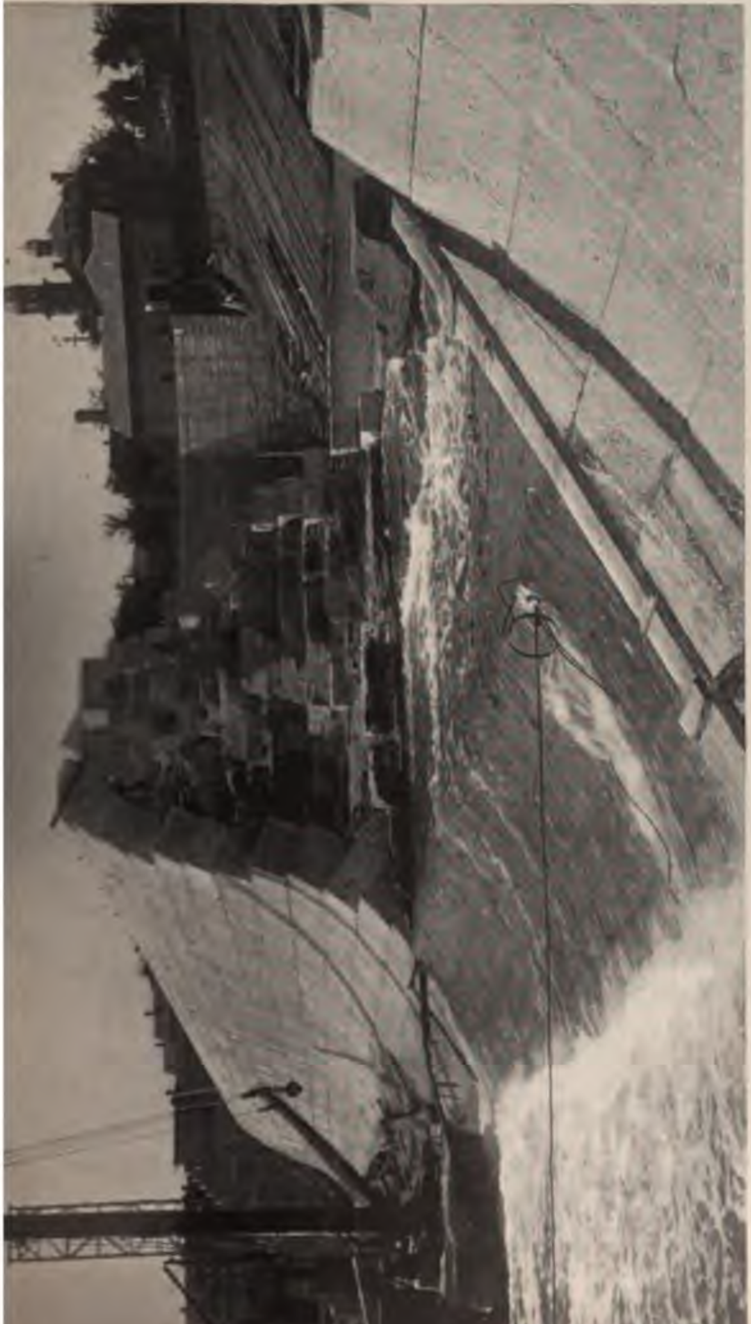
EQUIPMENT.

A Lidgerwood cableway of 1,615 ft. clear span was erected over the line of the dam, but it was found not to be adapted to the work of laying the stone, and its chief use was in the unloading of granite from cars and conveying it over the canal to the railroad, laid just below the toe of the dam and parallel to it. This railroad also extended to the quarry in the river bed about 1,000 ft. below the dam. It was equipped with a small locomotive and platform cars, which delivered all materials to stiff-legged boom derricks that transferred them to their places in the dam. The cableway was useful in removing the railroad track, derricks, hoisting engines, etc., from the bed of the river at the end of a season's work.



View of the Dam from the Holyoke Side.
By Courtesy of "The Engineering Record."

Sand of the best quality was obtained from a pit about two miles up the west side of the river. It was delivered on the bank of the river near the dam by railroad cars. Screening was done by an arrangement of screens, placed so that the sand was passed through them on its way down to the bed of the river. Mixing was done by hand in beds placed at the toe of the dam within reach of the derrick that tended the gang of masons to be supplied.



VIEW SHOWING SECTION OF DAM.

THE SYSTEM OF CANALS.

Water power of six different classes is used. On the South Hadley Falls side a group of three mills take water from the river by a short canal and discharge just below the dam.

On the Holyoke side there is a system of canals at three different levels. Philander Anderson was the chief engineer of the designing and construction of this system, as also of the laying out the street system of Holyoke.

Water is taken from each of the three levels and discharged directly into the river. It is also taken from the first level and discharged into the second and from the second and discharged into the third.

The river at the dam flows about S. 50° E. After forming a long bend it flows at the foot of the rapids about S. 50° W. Within this bend the system of canals and the manufacturing part of Holyoke are laid out.

The water enters the main canal through a bulkhead at the end of the old dam, 40 ft. wide, measured with the current. The bulkhead contains 12 large gate openings, each 8 ft. wide by 15 ft. deep, separated by piers 19 in. thick; and also two smaller gate openings 4½ ft. by 10½ ft. Each gate can be moved independently of every other by machinery, power for which is obtained by a water wheel located in the same building.

The main canal is about 1,000 ft. long, in a direction about S. 25° E., 20 ft. deep, 140 ft. wide at the bottom and 144 ft. at the top. Its walls are of solid masonry. The river wall adjacent to the bulkhead is a wasteway, 168⅔ ft. long. A portion of this near the centre, 30 ft. long, is built up higher than the surface of the water, and contains four waste gates, 5 ft. by 5 ft., placed with their centres 20 ft. deep, or at the general level of the bottom of the canal.

From the south end of the main canal the first level canal extends nearly S. W. about 5,800 ft. It is 10 ft. deep, 150 ft. wide at the entrance and has a decrease in width of 1 ft. in 100 ft. About 700 ft. of the original plan has not been constructed. The second level canal runs parallel to the first, 400 ft. from it and 20 ft. lower. It is 8 ft. deep. In the S. W. direction it is 6,300 feet long.

It also extends from the N. E. end in a curved direction, which follows the course of the river for 5,369 ft. This portion has not been extended to completion as projected. The fall from the second level to the third is 12 ft. From the second level to the river 25 to 28 ft.

The third level 5,225 ft. long, 100 ft. wide and 8 ft. deep, for the greater part of its length, runs parallel with the course of the river, and about 500 ft. from it. The fall here ranges from 15 to 28 ft., according to the stage of the river.

View of Completed Dam, February 14, 1900.

There is a wasteweir from the first level into the second level, and also one from the second level into the river. The height of water in the canals is controlled by means of flashboards at these several wasteweirs.

Stone masonry locks for navigation purposes were constructed from the river into the main canal at the south end of the bulkhead, and from the main canal into the second level canal. By the system as developed about 30,000 h. p. is utilized.

Descriptions of the new dam with drawings and illustrations were published in Engineering News May 13, 1897, and in Engineering Record for Aug. 29, 1896, and July 22, 1899.

The last stone in the Holyoke Dam was laid on January 5th, 1900. Two photographs of the water passing over the new dam are herewith shown. The first was taken on February 14th, 1900, when there was a head of eight feet of water on the crest. As previously described, the old wooden dam is located 170 feet up stream from the new dam. The descending water passing over the old dam, which acts as a submerged weir, is considerably disturbed before it reaches the new dam. This disturbance is shown in the photograph by the rough appearance of the surface of the water just as it reaches the crest. This roughness of the surface is also partly caused by running ice. The blank appearance of the river below the dam is caused by the dense cloud of mist which hung over the river.

VIEW OF COMPLETED DAM, FEBRUARY 14, 1900.

The photograph of February 24th, 1900, was taken when there was but two and one-half feet of water on the crest.

THE NEW WATER POWER OF THE HARTFORD ELECTRIC LIGHT COMPANY.

BY PROF. WM. LISPENARD ROBB.

During the past year the Hartford Electric Light Company has added to its water power by developing a second power on the Farmington River. This power is situated eleven miles from the central station in Hartford; approximately the same distance from Hartford as the power previously developed, but three miles further up the river. The dam is located at the lower end of what is known as the Tariffville gorge, about half a mile below Tariffville. The location for the new dam is ideal. The banks and bed of the river at this point are of trap rock, practically free from seams; the river is very narrow and the banks are almost vertical. The fall in the river which could be obtained at this point is 25 feet. About two hundred feet below the site of the dam the river is divided into two channels by an island about one thousand feet long. The fall in the river to and alongside this island is about six feet. There is no satisfactory site for a dam at the lower end of the island, as the river at this point is comparatively wide, the banks are low, and the bed of the river would not furnish satisfactory foundation. As it was desirable to obtain the six additional feet of fall the inlet into the narrow channel was closed and the channel deepened to make a satisfactory tail race, and thus to make it possible to use the six feet additional fall. The power house was located at the head of the tail race, about two hundred feet below the dam, it being found preferable to improve the channel above mentioned for a tail race rather than to extend the feeder pipes and locate the power house further down stream.

The dam was built of concrete, as there was no stone to be obtained in the immediate neighborhood for the construction of a stone dam. The trap rock taken from the wheelpit and from the

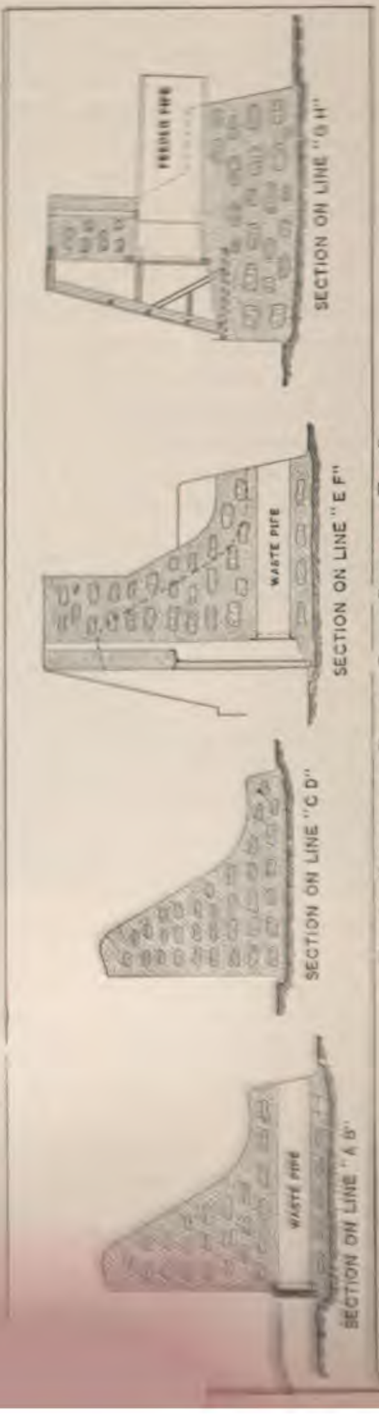


FIG. 6.—SECTIONS OF DAM ON LINES SHOWN IN FIG. 5.

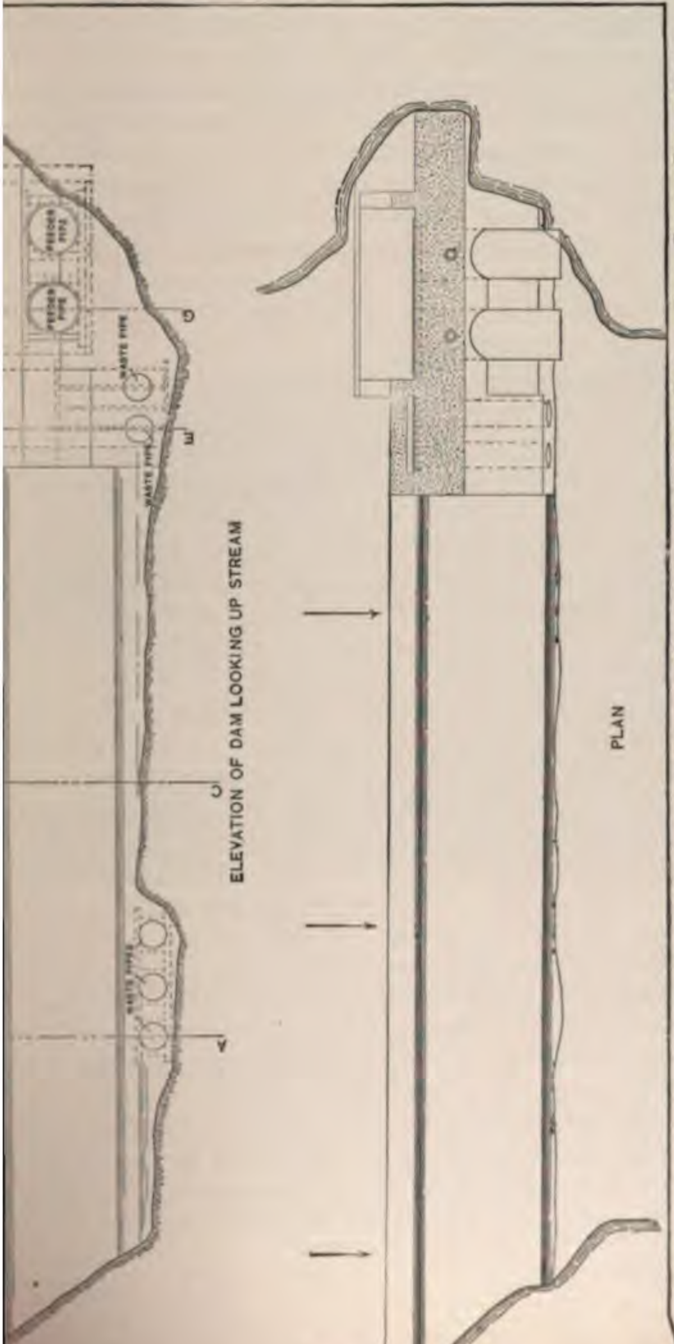


FIG. 5 —PLAN AND ELEVATION OF DAM, SHOWING LOCATION OF TEMPORARY WASTE PIPES FOR CARRYING FLOW OF RIVER DURING CONSTRUCTION.

upper end of the tail race proved just sufficient for the stone in the concrete. There was the further advantage in favor of the concrete dam that it could be constructed in very much shorter time than could a stone one. All the work, including dam, power house, machinery and transmission line, was completed within seven months after letting of contract. Sections of the dam are shown above in Fig. 6. The crest of the dam is about 180 feet long, while the waste-gate abutment, forebay and end abutment are about 80 feet long. The thickness of the dam at the base is about 32 feet, and at the crest 6 feet. The height of dam is about 25 feet above surface of water.

In preparing the foundation for the dam the water in the river was diverted by cofferdam and crib and the water was pumped out until rock was exposed. Loose gravel and rock were removed, and the old surface of the rock was taken off by squib blasts, so that the cement concrete could have a clean, sharp surface to which to adhere. All the surfaces of the rock were made to slope upstream. At the ends of the dam and abutment loose rock was removed and squib blasts were put in to remove the old surface.

The section on line, A B. shows the contour through the deepest part of the river. The cofferdam was built around this portion, and three waste pipes 5 feet in diameter were built in this portion of the dam as shown in the sectional drawing. These three waste pipes were capable of carrying the normal flow of the river during the further construction of the dam. On the upstream end of these waste pipes a timber frame was built in the dam, and when the dam was completed and ready to be filled they were permanently sealed with 12-in. by 12-in. Southern pine timber. The section on line E F indicates the construction through the waste-gate abutment, and shows two waste pipes 5 feet in diameter. These waste pipes are controlled by gates, and were built in the dam, so that the electric light company could control the level of the water on the dam, except in flood time. It was considered advisable to do this so that the electric light company could build the dam to the extreme height of the flowage rights which it controlled. In case the load is light the waste gates can be opened to prevent the water setting back on the next water power. Section on line G H is taken through a feeder pipe. The feeder pipes are 9½ feet in diameter and about 200 feet long.

The dam, forebay and abutments are built of concrete. First, a bed of concrete, 12 inches deep was made; then blocks of stone were placed in the soft concrete with the smallest surface down. These stones were not allowed to come within 12 inches of each other. Concrete for the body of the dam and abutments, where random block stone was allowed to be used, was composed of one part Portland cement, having a tensile strength of 500 pounds to the square inch, of three parts clean, sharp sand, and three parts broken stone that screened 2 inches. The block stone used was taken from the trap-rock excavation for the wheelpit and consequently had clean sharp surfaces. Twelve inches of the outside of the dam and all the outside surface were built of concrete composed of one part Portland cement, three parts of clean sharp sand and two parts of broken stone that screened one-half inch. The completed dam and abutments and a portion of two of the

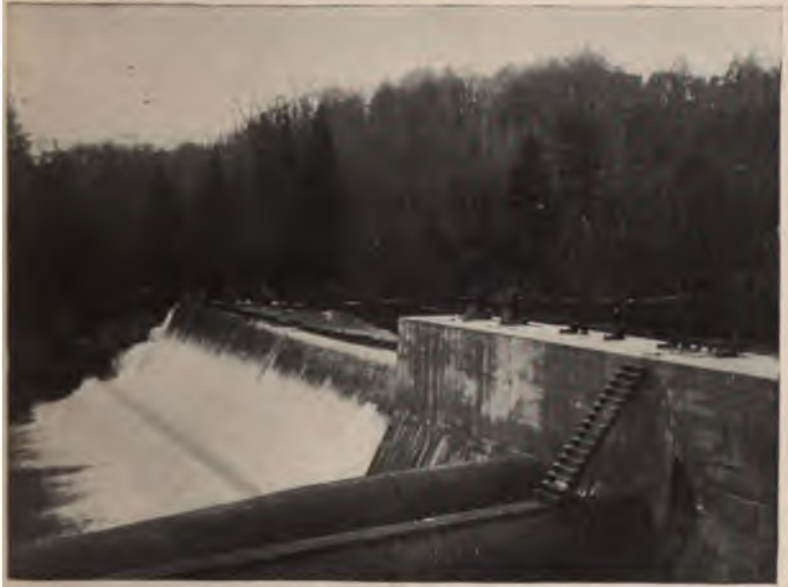


FIG. 7.—COMPLETED DAM.

feeder tubes are shown in Fig. 7. The view of the river above the dam, showing the boom for keeping the ice and driftwood away from the feeder tubes is shown in Fig. 3. This boom is constructed in the form of a truss out of 12-inch by 12-inch timber, braced with 3-inch planking. The tail race, which was constructed by deepening the narrow channel of the river about 4 feet is shown in Fig. 1.

The power house is 42 feet wide by 84 feet long, and 29 feet from the floor to the lowest chord of the roof trusses The bottom of the tail race under the power station is excavated 24 feet below the floor, and the water in the tail race stands 15 feet below the floor of the station.

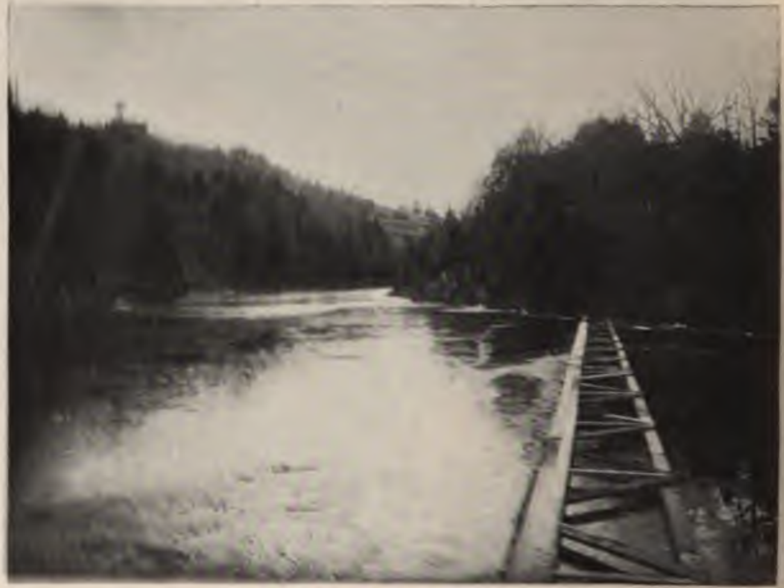


FIG. 3.—RIVER ABOVE DAM.

The floor of the station and the machinery, including generators and wheels, are carried on concrete arches built in the tail race. The concrete used in these arches is composed of one part Portland cement, three parts of sand and four parts of broken stone which screened 2 inches. The exterior of the power house with lightning arrester and oil house, are shown in Fig. 10.

EQUIPMENT OF POWER HOUSE.

Power is developed by means of two pairs of horizontal turbine wheels, each pair capable of delivering to generator coupling 1150 h. p. at 164 r.p.m., with 29 feet working head. These wheels were manufactured by the Stilwell-Bierce & Smith-Vaile Co. Each pair of wheels is set in a flume 12 feet in diameter and 23 feet long, made of 5-16-in. steel, and discharges into a centre cast-iron case, with a draft tube flaring from 8½ to 11½ feet in diameter, 23 feet long, and made of ⅛-inch steel. The wheel shafts are made of the best forged steel 7⅜ inches in diameter, and direct-connected by standard face couplings to the shaft generators. There are two wheels for exciters, each set in a cast iron case, and capable of delivering to each exciter 45 h. p. at 550 r.p.m., under 29 feet working head. The draft tube of each exciter wheel is con-

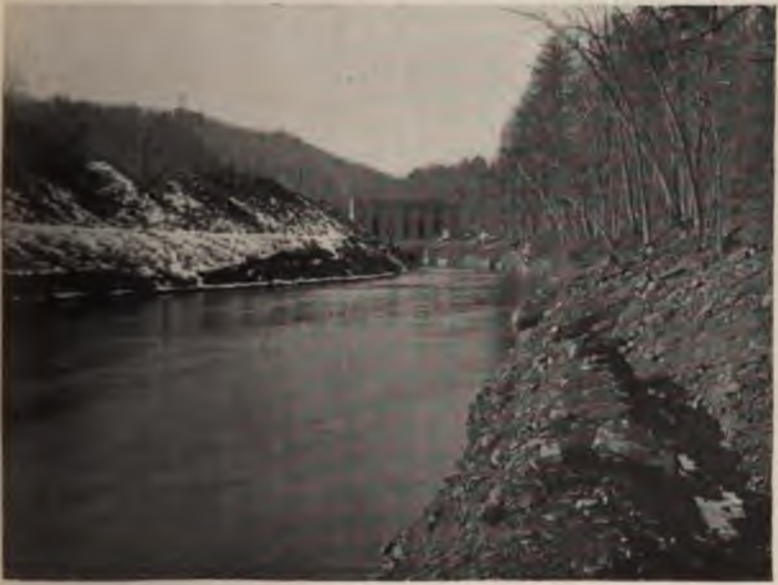


FIG. 1.—TAIL RACE.

nected to the draft tube of the generator wheel, and the exciter feeders are tapped out of the sides of the flumes of the main wheels. Each pair of generator wheels is direct-connected to a 750-kw. generator, and each exciter wheel is connected to a 30-kw. generator. Fig. 4 shows one of the two generating sets complete with exciter set.

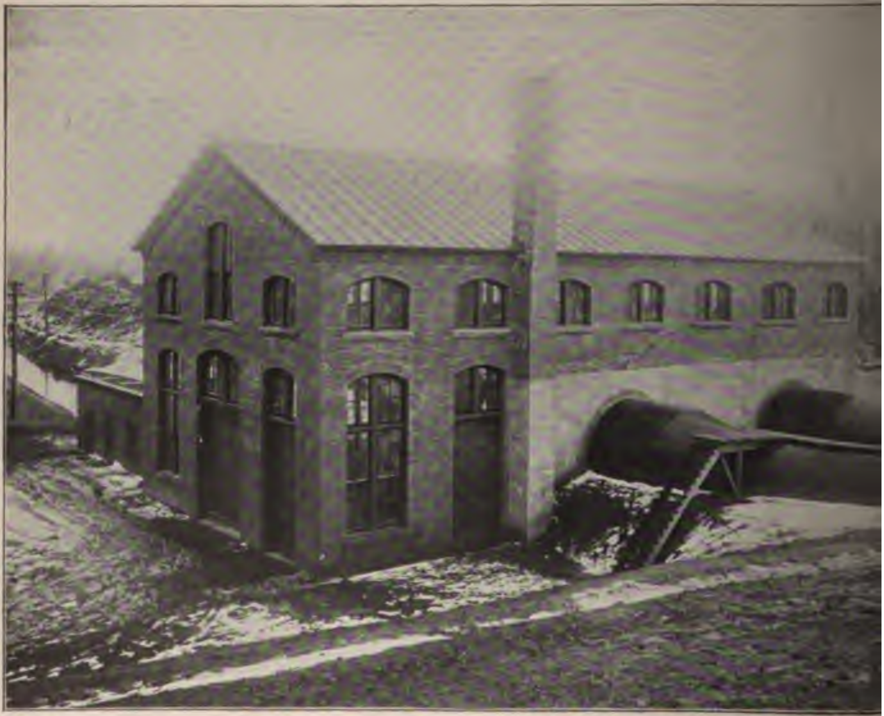


FIG. 10.—VIEW OF POWER HOUSE FROM UP-STREAM SIDE.

The station is equipped with a motor-driven air compressor having a capacity for compressing 5 cu. ft. of free air per minute against 150 lbs. pressure to the square inch. The compressor is connected with the necessary piping and valves to the generators and switchboard, and the air thus compressed is used for cleaning the apparatus.

The station is equipped with a 15-ton travelling crane, and

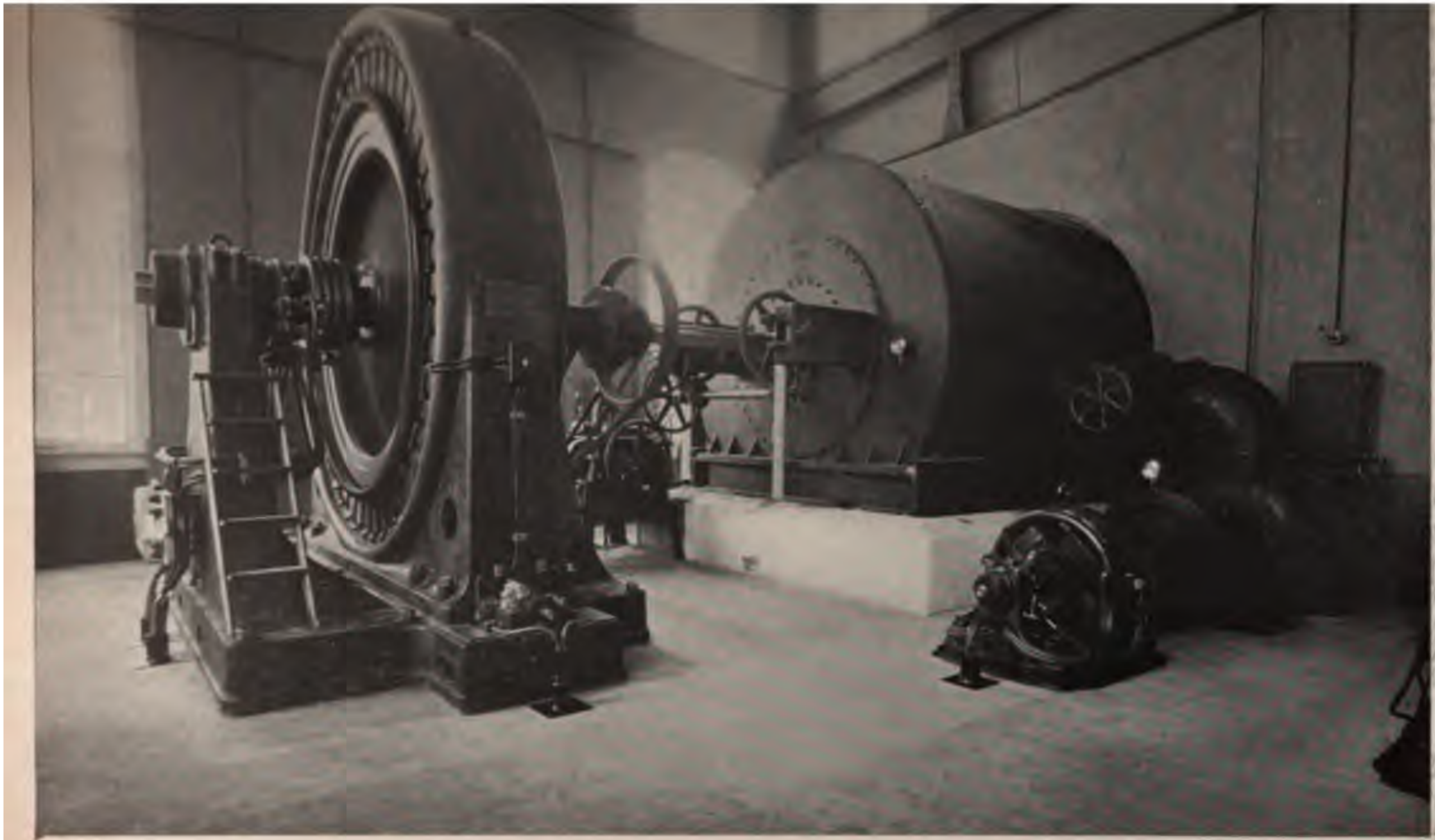


FIG. 4.—ONE COMPLETE SET OF WHEELS, GENERATOR AND EXCITER.

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the crane can be use

The generators w
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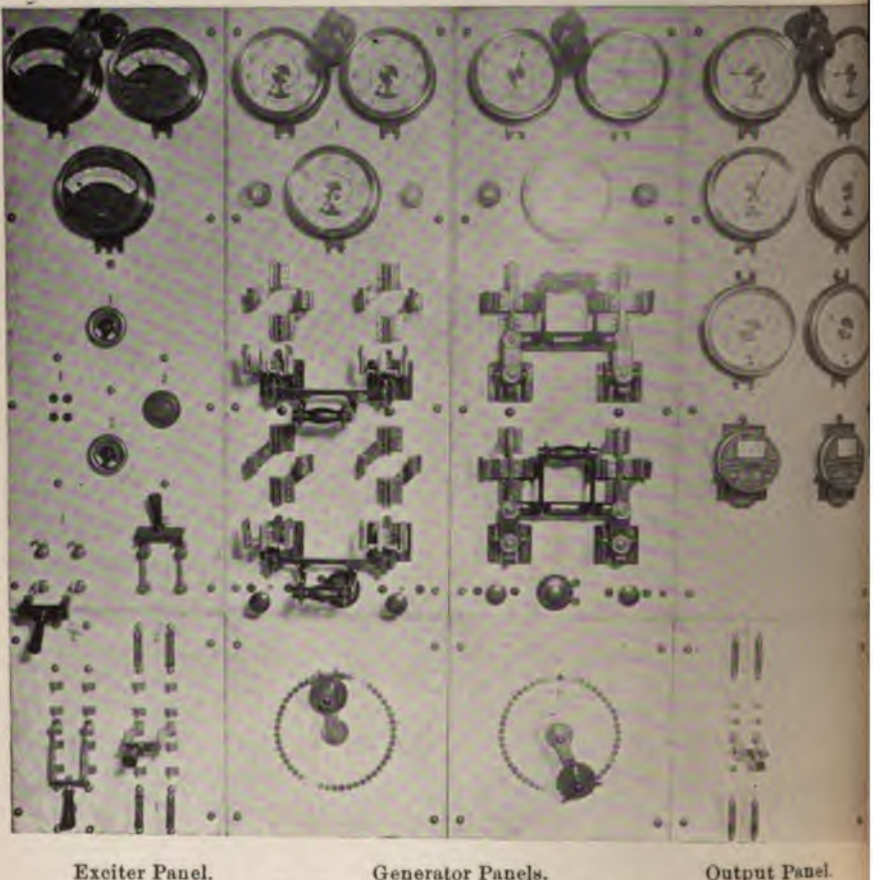
FIG. 8.—A VIEW OF THE SWITCHBOARD.

nating current under a pressure of 500 volts. The current
to raising transformers and is changed over to a three-pha
rent under a pressure of 12,000 volts, at which it is tran
to the central station at Hartford. At Hartford the pre

[illegible]
meter for each phase.
interesting features of this particular trans-
. The current is transmitted from Farming-
er aluminum wire, this being the first case in
wire has been used. The wire used is equiva-
to No. 0000 copper. The line was built of

the water wheel casings are brought into the power house so that the crane can be used in handling all machinery.

The generators were manufactured by the Westinghouse Electric & Manufacturing Company, and generate two-phase alternating current under a pressure of 500 volts. The current passes to raising transformers and is changed over to a three-phase current under a pressure of 12,000 volts, at which it is transmitted to the central station at Hartford. At Hartford the pressure is



Exciter Panel. Generator Panels. Output Panel.

FIG. 8.—A VIEW OF THE SWITCHBOARD.

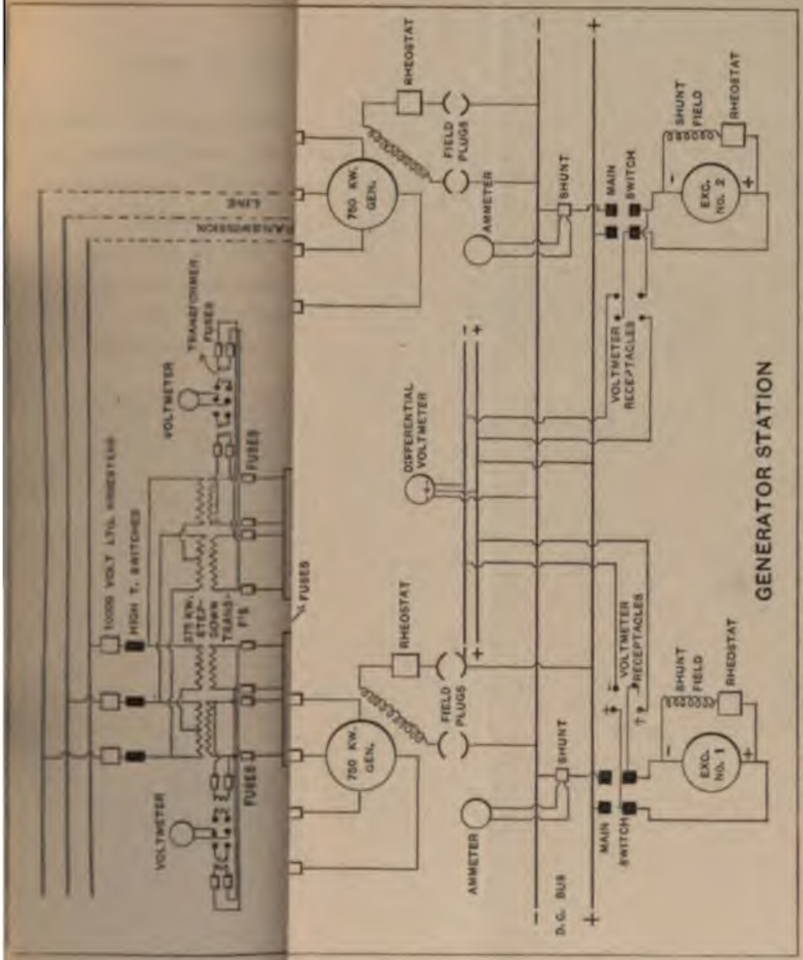


FIG. 11.—DIAGRAM OF CIRCUITS OF GENERATING AND SUB-STATIONS.

and recording wattmeter for each phase.

One of the most interesting features of this particular transmission is the line. The current is transmitted from Farmington to Hartford over aluminum wire, this being the first case in the East where this wire has been used. The wire used is equivalent in conductivity to No. 0000 copper. The line was built of

the water wheel casings are brought into the power house so that the crane can be used in handling all machinery.

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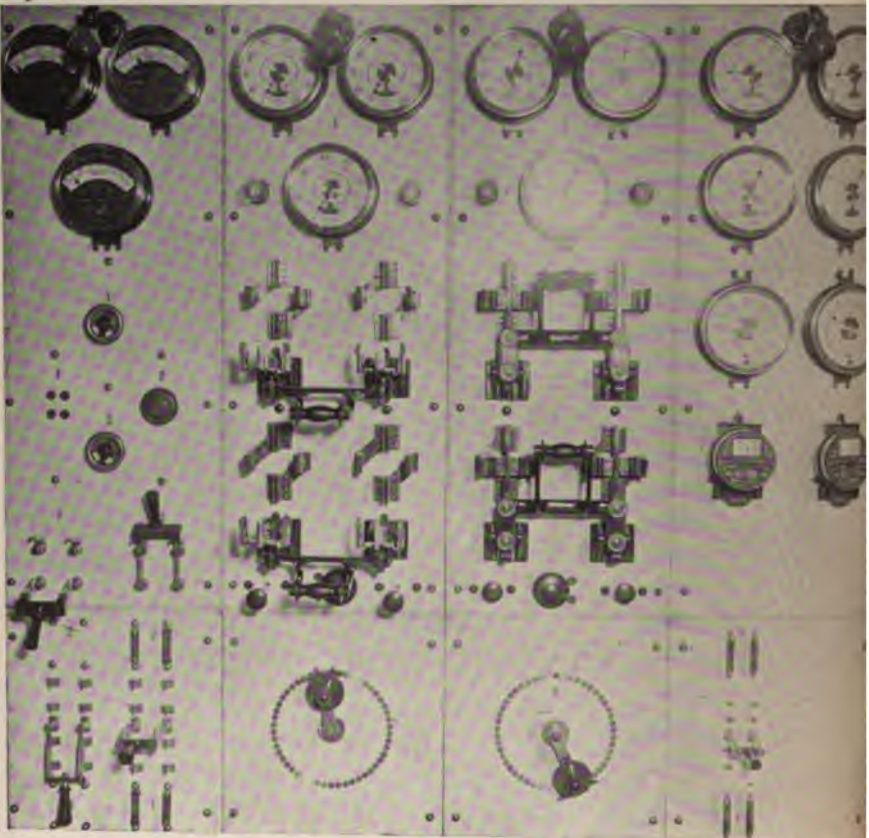

Exciter Panel. Generator Panels. Output Panel.

FIG. 8.—A VIEW OF THE SWITCHBOARD.

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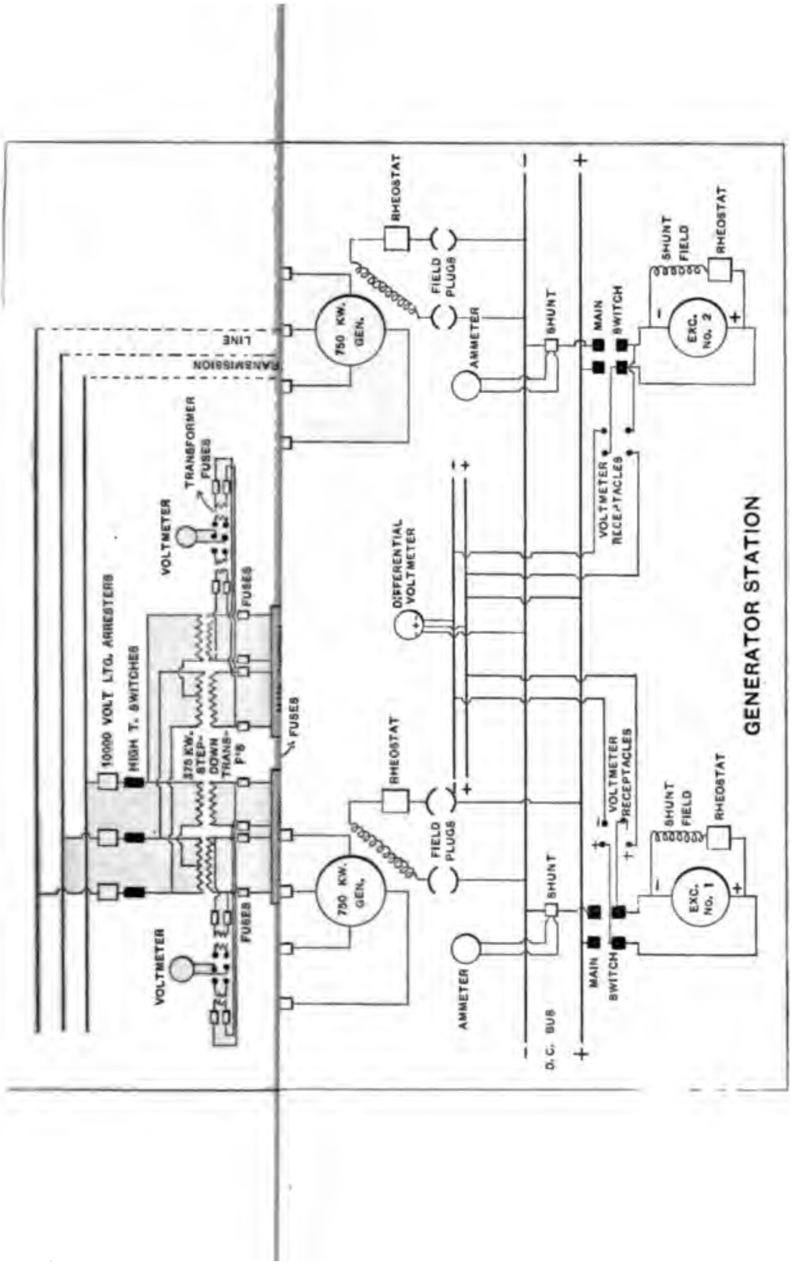

FIG 11.—DIAGRAM OF CIRCUITS OF GENERATING AND SUB-STATIONS.

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FIG. 8.—A VIEW OF THE SWITCHBOARD.

nating current under a pressure of 500 volts. The current passes to raising transformers and is changed over to a three-phase current under a pressure of 12,000 volts, at which it is transmitted to the central station at Hartford. At Hartford the pressure is lowered to 2400 volts, and feeds into the busbars in parallel with the current from the other water power station, and the local steam station. Electrically, the two water power stations are situated 22 miles apart.

A diagram of the connections of switchboard is shown in Fig. 11, and Fig. 8 is an illustration of the switchboard at the power station. The switchboard consists of four panels. The first contains ammeters and voltmeter for the exciters, the second the necessary switches for both phases of one of the generators. The third panel is similar to the second. The fourth panel is a load panel, and contains ammeter, voltmeter, indicating wattmeter and recording wattmeter for each phase.

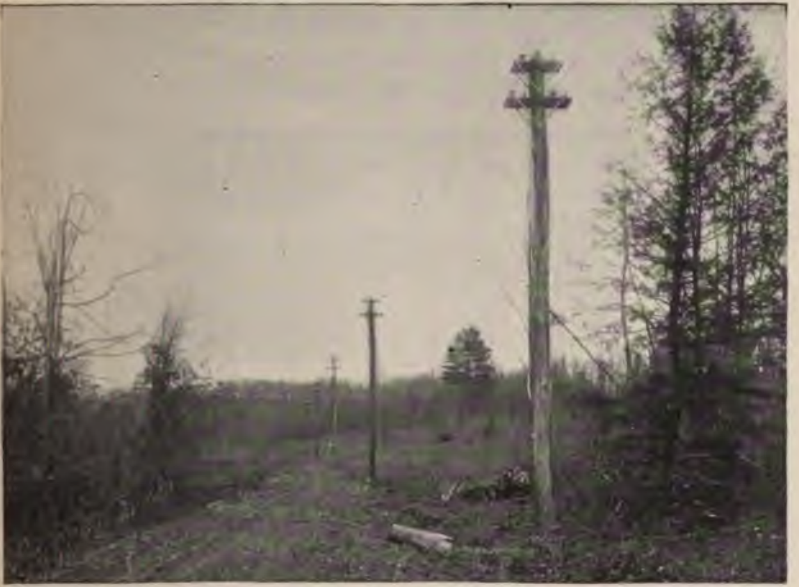

FIG. 2.—TRANSMISSION LINE.

One of the most interesting features of this particular transmission is the line. The current is transmitted from Farmington to Hartford over aluminum wire, this being the first case in the East where this wire has been used. The wire used is equivalent in conductivity to No. 0000 copper. The line was built of

aluminum primarily because it could be purchased at 20 per cent. less than copper having the same conductivity. The wire used is made of seven strands. Until the wire reaches the underground district in Hartford, it passes along a private right-of-way; the first half mile over property of the electric light company and the remaining distance along the tracks of the Central New England Railroad. The wire used is not insulated, the insulation relied on being the porcelain insulators on which the line is supported. The porcelain insulators are double petitioned, about 6 inches in diameter at the base. The wire was furnished in lengths of about 2,000 feet. The joints were made in the following manner. The ends of the wire were first cleaned with hydrofluoric acid and then turned over. The strands of wire were somewhat spread apart, and placed end to end in a brass casting, the inside of which was somewhat oval. The casting was then filled with block tin. A test of several of these joints was made in a testing machine, and their tensile strength proved to be greater than that of the line itself. Figs. 2 and 9 show the general construction of the line, and one of the joints in the aluminum wire.

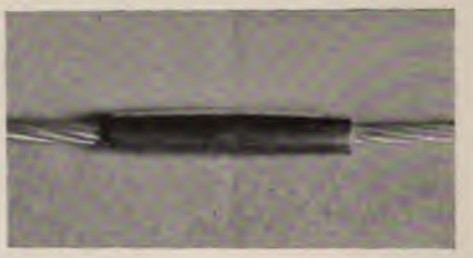

FIG. 9.—JOINT IN ALUMINUM LINE.

The total cost of this development, inclusive of water rights and transmission line, was $125 per horse power. The specifications and drawings for the dam and hydraulic machinery were furnished by Mr. A. C. Rice of Worcester, Mass., who acted as consulting hydraulic engineer to this work.

The author acted as consulting electrical engineer and was the resident engineer in charge of all the work, both electrical and hydraulic.

DISCUSSION.

Mr. Ford.—Can you tell us approximately the number of cubic yards in the dam?

Prof. Robb.—The cost of the concrete was, I think, $7.10 per yard, and there were about 6,000 yards of concrete.

Question.—How far is the distance of transmission?

Prof. Robb.—Within a few feet of eleven miles.

Question.—How much cement to the yard was used?

Prof. Robb.—I cannot give that off hand.

Question.—What system of regulation do you use on the water wheels?

Prof. Robb.—Giessler governors were furnished under the contract, but have not been accepted, as they do not as yet meet the specifications. The specifications call for the governors regulating within 5% under a variation in load of 50%. As a matter of fact the variations in load are very small, owing to the large storage battery owned by the Hartford Electric Light Co. This battery is always on the system and takes care of the fluctuations, except when a short circuit occurs on the transmission line.

On Tuesday, February 13th, 1900, there was a heavy fall of rain, probably three and one-half to three and three-quarters inches, which rapidly raised all of the streams in the Farmington River water shed. On Wednesday, February 14th, 1900, at 10 A. M., a member of this Association took two photographs of the water going over the dam of the Hartford Electric Light Company at Tariffville, Connecticut. Thinking that these views will be of interest to our members, they are herewith reproduced. At the time the photographs were taken the water some distance back from the crest of the dam was at elevation 67.5. The top of dam is at elevation 58.0; the top of the bulkhead wall is at elevation 66.0.

TARIFFVILLE DAM, FEBRUARY 14, 1900.

TARIFFVILLE DAM, FEBRUARY 14, 1900.

LIST OF EX-PRESIDENTS.

WITH DATES OF SERVICE.

B. H. Hull	1884, 1885
Charles M. Jarvis	1886
Charles E. Chandler	1887
Charles H. Bunce	1888, 1889
F. Floyd Weld	1890
E. P. Augur	1891, 1892, 1893, 1894
Wm. G. Smith	1895, 1896
Robert A. Cairns	1897, 1898

CONNECTICUT

Civil Engineers and Surveyors Association.

CONSTITUTION.

ARTICLE I.

Section 1.—The name of this Association shall be the CONNECTICUT CIVIL ENGINEERS AND SURVEYORS ASSOCIATION.

Object.

Sec. 2.—The object of this Association shall be the professional improvement of the members, the encouragement of social intercourse among men of practical science, and the advancement of engineering in its several branches; to wit: civil, hydraulic, mining, sanitary, and mechanical; the reading and discussion of papers on any of the above topics relating to engineering science, and the transaction of all business properly belonging to said Association.

ARTICLE II.

Officers and Their Duties.

Section 1.—The officers of the Association shall be a President, two Vice-Presidents, Secretary, Assistant Secretary, Treasurer, Executive Committee, consisting of five members, Committee on Membership, consisting of three members.

Sec. 2.—All officers shall be elected annually, on the second Tuesday of January, and shall hold their respective offices until the final adjournment of the meeting at which others are elected and qualified in their places.

President, Duties of.

Sec. 3.—The President shall be Chairman of all Standing Committees, with no power to vote except in case of a tie. He shall preside at all meetings when present, and shall appoint all Special Committees unless otherwise ordered by a vote of the Association.

Vice-President.

Sec. 4.—In the absence or inability of the President to act, the Vice-President shall perform his duties.

Secretary.

Sec. 5.—The Secretary shall carefully keep all records, and attend to all the correspondence of the Association, and transact all other business pertaining to his office.

Treasurer.

Sec. 6.—The Treasurer shall keep the accounts, receive all funds of the Association, and disburse the same when approved by the Executive Committee, and render such statements of the financial condition of the Association as the By-Laws may require.

Committee on Membership.

Sec. 7.—The Committee on Membership shall consist of three members, whose duties shall be to consider all propositions for membership, to inquire into the qualifications and desirability thereof, and report thereon to the Association.

ARTICLE III.

Elections.

Election of Officers.

Section 1.—The election of officers shall be by ballot. The voting for officers shall be at first informal, the two highest candidates being subsequently voted for.

Election of New Members.

Sec. 2.—No new members shall be voted for except at regular meetings of the Association. In voting for members, two adverse ballots shall exclude any applicant. A rejected candidate shall not be voted for again within the next year unless otherwise ordered by a unanimous vote.

Proxies.

Sec. 3.—Any active member may vote at all meetings by the properly attested proxy held by some active member.

ARTICLE IV.

Regular Meetings.

Section 1.—There shall be a regular meeting held on the second Tuesday of January each year, at such place as may be selected by the Executive Committee, of which due notice shall be given; and at such other times and places as shall be agreed upon by the Association, due notice to be given by the Secretary of the Association.

Special Meetings.

Sec. 2.—Special meetings may be called by the President at any time; and when so called, notice of the meeting, specifying the business thereof, shall be served by the Secretary upon each member at least ten days before such meeting shall be holden. Special meetings may also be called by any three members who shall proceed in the manner above laid down, and shall append their names to the call.

Quorum.

Sec. 3.—At any regular or special meeting, ten members shall constitute a quorum for the transaction of business, except for the election of officers and amending of Constitution and By-Laws, when the number shall be eleven (11).

ARTICLE V.

Section 1.—The membership of this Association shall consist of Active, Honorary, and Contributing Members.

Active Members.

Sec. 2.—Active Members must be at least twenty-one years of age, and have had two years' actual practice in engineering or surveying, and they only shall be entitled to vote or transact business for the Association.

Honorary Members.

Sec. 3.—Honorary Members may be as many as the Association shall elect, and they shall have the right to attend all public meetings, and to enjoy such other privileges as the Association shall see fit to grant them.

Contributing Members.

Sec. 4.—Any person recommended by some Active Member acquainted with him, and by the Committee on Membership, may become a Contributing Member on the payment of five dollars ($5) per annum, and shall be entitled to attend the public meetings and receive the publications of the Association, but shall not be entitled to vote or hold office. Contributing Members shall be entitled to speak in the meetings whenever so voted by two-thirds of the Active Members present.

Requirements.

Sec. 5.—No person will be admitted as a member of the Association unless said person has had two years' actual practice in engineering or surveying, and is twenty-one years of age.

ARTICLE VI.

Dues, Fines, Duties, and Penalties.

Dues.

Section 1.—The dues of Active Members shall be three dollars ($3) per year, payable in advance yearly.

Fines.

Sec. 2.—Any member failing to pay the dues for one year, shall be considered to have resigned from the Association, and shall have no further connection with it unless otherwise ordered by special action of the Association.

Duties.

Sec. 3.—The Constitution, and all amendments thereto legally adopted by the Association, shall be engrossed in a book specially provided for that purpose, and all who are now or may become members shall subscribe their names thereto, and pledge themselves to a faithful observance of its provisions.

Penalties.

Sec. 4.—For the violation of any article of the Constitution or the amendments thereto, a member shall be liable, upon a majority vote, to be reprimanded or suspended, and, upon a two-thirds' vote of the Association, to be expelled.

ARTICLE VII.

Visitors.

Section 1.—At other than a meeting for the election of officers or members, or for the transaction of business, visitors may be admitted at all the meetings of the Association, under such rules as the Association may see fit to impose.

BY-LAWS.

ARTICLE I.

Meetings of the Association.

Section 1.—The annual and business meeting of the Association shall be holden on the second Tuesday of January each year, at such place as may be decided upon by the Executive Committee, due notice thereof being given by the Secretary at least ten days before the time for holding such meeting—for the Election of Officers for the ensuing year, Reports of Secretary, Treasurer, Executive Committee, and to do any other business proper to be done at said meeting.

Sec. 2.—Regular meetings for the Reading of Papers, and the discussion of Scientific Subjects, pertaining to Engineering, shall be holden at least once a year, at such time and place as may be agreed on by the Association.

Sec. 3.—Special meetings may be called by the President, and shall be called at the request of five members in writing.

Sec. 4.—Notices of meetings shall be issued by the Secretary ten days prior to the date of meeting, by mailing the same to the address of each member.

Sec. 5.—Notices of special meetings shall contain a statement of the object for which the meeting is called. And no subject not stated in such notice shall be decided at any special meeting.

ARTICLE II.

Annual or Business Meetings.

Section 1.—The following order of business shall be observed at the annual meeting:

1. Minutes of last business meeting and of subsequent special meeting read and approved.
2. Report of Secretary.
3. Report of Treasurer.
4. Report of Executive Committee.

5. Report of any Special Committee.
6. Election of New Members.
7. Election of Officers.
8. Address by the President.
9. Miscellaneous Business.
10. Reading and discussion of any Papers.

Regular Meetings.

Sec. 2.—The following order of business shall be observed at the regular meetings:

1. Minutes of last regular meeting and of subsequent special meeting read and approved.
2. Report of Secretary.
3. Report of Treasurer.
4. Report of Executive Committee.
5. Report of any Special Committee.
6. Nomination of New Members.
7. Election of New Members.
8. Unfinished Business.
9. New Business.
10. Communications.
11. Report of Committee on Information, and discussion.
12. Miscellaneous Announcements, Papers, Items, Notes, or Communications.

ARTICLE III.

Section 1.—All nominations for members shall be referred to the Committee on Membership, who shall report at the same meeting, an adverse report from whom shall indefinitely postpone its consideration, and no ballot shall be taken on a nomination until a report thereon is made from the Committee.

Sec. 2.—In case of Honorary Members, a unanimous vote is requisite to elect.

Sec. 3.—Contributing and Honorary Members may attend all meetings, but shall not vote nor be eligible to office.

ARTICLE IV.

Deprivation of Membership.

Section 1.—If any member shall be one year in arrears for dues to the Association, and shall neglect or refuse to pay the same within thirty days after notification from the Treasurer, his name shall be stricken from the Roll of Members.

Sec. 2.—Resignations may be submitted in writing at a business meeting. But no resignation shall be accepted until all dues and other indebtedness to the Association shall have been discharged.

Sec. 3.—A member may be expelled for cause deemed sufficient by the Association, by a two-thirds' vote of the members present at a business or special meeting, provided such member shall have had at least two months' notice of the charges preferred against him, and of the time for their consideration.

ARTICLE V.

Section 1.—The Executive Committee shall be composed of five members of the Association, annually elected by said Association. They shall have the general management of the affairs of the Association, and shall hold meetings at such times as they may fix, and shall report their transactions at each business meeting of the Association. They shall have power to fill all vacancies in their own number, or among the officers.

ARTICLE VI.

Section 1.—The Association may at any meeting duly named for the purpose, enact By-Laws for the future guidance, consonant with the Constitution, which By-Laws may be amended or repealed at any meeting, notice thereof having been previously given.

ARTICLE VII.

Amendments.

Section 1.—Amendments to the Constitution, or additions thereto, may be made at any regular meeting, on assent of three-fourths of the members present or represented by proxies, provided that written notice of said change shall have been read and filed with the Secretary at some preceding regular meeting, and a copy of the same posted in some conspicuous place in the room where such meeting is held, and mailed to each of the members of said Association at least ten days before such meeting.

LIST OF MEMBERS.

WITH ADDRESSES AND DATES OF ELECTION.

Members are particularly requested to keep the Secretary constantly informed as to their correct addresses.

HONORARY MEMBERS.

JOHN E. CLARKE..April, 1884
Prof. Mathematics at Sheffield Scientific School of Yale University, New Haven, Conn.

GEORGE H. FROST..April, 1884
Prest. Engineering News Publishing Co., New York.

EDWARD C. HAYNES..Jan. 14, 1890
Agent John Hancock Mutual Life Ins. Co., Springfield, Mass.

WILLIAM E. PETTEE..Jan. 10, 1899
Civil Engineer, Lakeville, Conn.

FRANK W. SKINNER..Jan. 9, 1900
Editorial Staff of the Engineering Record, New York.

ROBERT R. SMITH..June 7, 1887
Civil Engineer, New Hartford, Conn.

EDWARD S. WATERS..Jan. 9, 1900
Chief Engineer Holyoke Water Power Co., Holyoke, Mass.

ACTIVE MEMBERS.

ARTHUR A. ADAMS..Jan. 9, 1900
Supt. of Streets, Springfield, Mass.

JULIUS L. ADAMS..July 18, 1899
Chief Engineer Hartford, Manchester and Rockville Tramway Co., South Manchester, Conn.

ALGERNON B. ALDERSON..Jan. 10, 1899
Town Engineer, West Hartford, Conn.

ROSWELL ATKINS..Jan. 12, 1897
Civil Engineer and Surveyor, Bristol, Conn.

EDWIN P. AUGUR..April, 1884
City Surveyor, Middletown, Conn.

HENRY W. AYRES..Jan. 13, 1885
Hydraulic Engineer, Hartford, Conn.

JOHN W. BACON..Jan., 1884
Civil Engineer, Danbury, Conn.

SAMUEL E. BARNEY..Jan. 9, 1900
Prof. Civil Engineering Sheffield Scientific School, New Haven, Conn.

CHARLES EDWARD BEACH..Jan. 10, 1893
Civil Engineer, West Hartford, Conn.

CLIFFORD H. BELDEN..March 30, 1900
Civil Engineer, Hartford, Conn.

RAYMOND F. BENNETT..March 30, 1900
Bridge Department, N. Y., N. H. & H. R. R., New Haven, Conn.

GEORGE H. BISHOP..Jan. 13, 1885
Hydraulic Engineer, Middletown, Conn.

CLARENCE BLAKESLEE..Jan. 9, 1900
Civil Engineer and Contractor, New Haven, Conn.

JAMES P. BOGART..Jan. 9, 1900
Civil Engineer, New Haven, Conn.

DANIEL E. BRADLEY...Jan. 9, 1894
Manager Contracting Dept. Berlin Iron Bridge Co., East Berlin, Conn.

D. S. BRINSMADE..April, 1884
Engineer Housatonic Water Power Co., Derby, Conn.

CHARLES O. BROWN...Jan. 11, 1898
Civil Engineer and Surveyor, Danbury, Conn.

EDMUND BROWN..Jan. 10, 1899
Supt. and Engineer of Norfolk Water Co., Norfolk, Conn.

E. L. BROWN..Oct. 27, 1886
Civil Engineer, Brockton, Mass.

HENRY R. BUCK..Jan. 10, 1899
City Engineer's Office, Hartford, Conn.

JOHN E. BUDDINGTON..March 30, 1900
Consulting Engineer and Contractor, New Haven, Conn.

CHARLES H. BUNCE...April, 1884
City Engineer, Hartford, Conn.

LUTHER W. BURT..Jan. 13, 1885
Civil Engineer and Surveyor, Hartford, Conn.

EDWARD W. BUSH...Jan. 10, 1899
Assistant Engineer Conn. River Bridge and Highway District,
Hartford, Conn.

EMIL CHARLES BUSCHOR......................................Jan. 10, 1893
Civil Engineer and Surveyor, Central Valley, New York.

WILLIAM H. CADWELL...May 31, 1893
City Engineer, New Britain, Conn.

ROBERT A. CAIRNS..Aug. 29, 1890
Sanitary and Hydraulic Engineer and City Engineer, Waterbury,
Conn.

HUBER D. CARD..Oct. 24, 1895
Civil Engineer and Surveyor, Willimantic, Conn.

HARRY E. CARLISLE..Jan. 9, 1900
Engineer S. N. E. Telephone Co., New Haven, Conn.

RALPH B. CARTER..Jan. 14, 1890
Civil Engineer, 35 Dey St., New York.

CHARLES F. CHASE..March 30, 1900
Engineer Berlin Iron Bridge Co., New Britain, Conn.

CHARLES E. CHANDLER...April, 1884
Civil Engineer, Norwich, Conn.

RICHARD OTIS CHENEY, JR.....................................Jan. 9, 1900
Civil Engineer H. & C. W. R. R., Tariffville, Conn.

CLARENCE H. CLARK..March 30, 1900
Draughtsman N. Y., N. H. & H. R. R., New Haven, Conn.

EDGAR CLARK..June, 1887
Civil Engineer and Surveyor, Putnam, Conn.

HERBERT G. CLARK..July 18, 1899
Engineer of Keney Park, Hartford, Conn.

ROSCOE N. CLARK..July 18, 1899
Civil Engineer Dept. of Public Works, Hartford, Conn.

WILLIAM S. CLARK..Jan. 14, 1890
City Engineer, Meriden, Conn.

WILLIAM B. COCHRANE..Jan. 14, 1890
Civil Engineer, Stamford, Conn.

THEODORE I. COE..Jan. 9, 1900
Constructing Engineer with Isaac Allen, Architect, Hartford, Conn

R. C. P. COGGESHALL..June, 1887
Supt. of Water Works, New Bedford, Mass.

ALEXANDER COHN..Jan. 9, 1900
Civil Engineer, New Haven, Conn.

HARRY C. COLLINS..July 18, 1899
Collins & Norton, N. E. Agents of Pittsburg Bridge Co., Springfield, Mass.

GEORGE K. CRANDALL..Jan. 11, 1887
Civil Engineer and Surveyor, New London, Conn.

CHARLES M. CRAWFORD..July 18, 1899
Secretary Hartford Paving and Construction Co., Hartford, Conn.

NORMAN McDONALD CRAWFORD..July 18, 1899
General Manager Hartford Street Railway Co., Hartford, Conn.

FAYETTE S. CURTIS..Jan. 9, 1900
Vice President N. Y., N. H. & H. R. R., New Haven, Conn.

LOREN E. DABOLL..Jan. 8, 1895
City Surveyor, New London, Conn.

COURTLAND R. DARROW..Jan. 8, 1895
With William G. Smith, Waterbury, Conn.

HENRY L. DAVIS..Jan. 14, 1890
Civil Engineer, Wallingford, Conn.

ARTHUR L. DAVIS..July 18, 1899
Assistant Manager, Berlin Iron Bridge Co., East Berlin, Conn.

FREDERICK DE PEYSTER..Sept. 3, 1891
General Manager of the Brainerd, Shaler and Hall Quarry Co., Portland, Conn.

SOLOMON LE F. DEYO..Jan. 9, 1900
Chief Engineer New York Rapid Transit Subway Construction Co., New York City, N. Y.

AUGUSTUS J. DU BOIS..Jan. 9, 1900
Prof. Civil Engineering Sheffield Scientific School of Yale University, New Haven, Conn.

FREDERICK J. EASTERBROOK..March 30, 1900
Asst. Engineer N. Y., N. H. & H. R. R., New Haven, Conn.

CHARLES W. EDDY..Jan. 9, 1900
Civil Engineer and Surveyor, Simsbury, Conn.

JAMES H. EDWARDS..Jan. 10, 1899
Chief Engineer Berlin Iron Bridge Co., East Berlin, Conn.

FREDERICK H. ELLSWORTH.................................March 30, 1900
Asst. Engineer N. Y., N. H. & H. R. R., New Haven, Conn.

CHARLES H. EWING..Jan. 9, 1900
Chief Engineer Central New England Railway, Hartford, Conn.

CHARLES A. FERRY..Jan. 9, 1900
Civil Engineer and Surveyor, New Haven, Conn.

GEORGE A. FRENCH...March 30, 1900
Local Manager S. N. E. Telephone Co., Hartford, Conn.

FREDERICK L. FORD...Jan. 12, 1897
Assistant City Engineer, Hartford, Conn.

EDWARD GAGEL...Jan. 9, 1900
Division Engineer N. Y., N. H. & H. R. R., West Haven, Conn.

CHRISTOPHER M. GALLUP......................................Jan. 10, 1899
City Engineer's Office, Hartford, Conn.

GEORGE W. F. GILLETTE..Jan. 9, 1900
City Engineer's Office, New Haven, Conn.

HENRY H. GLADDING..Jan. 9, 1900
Assistant City Engineer, New Haven, Conn.

EDWARD O. GOSS..Nov. 29, 1890
Engineer Scovil Mfg. Co., Waterbury, Conn.

EDWIN D. GRAVES..Oct. 25, 1895
Chief Engineer Conn. River Bridge and Highway District,
Hartford, Conn.

JAMES S. HALL...Jan. 10, 1899
City Engineer, Ansonia, Conn.

MORRISON C. HAMILTON...Jan. 9, 1900
With N. Y., N. H. & H. R. R., Hartford, Conn.

JOHN T. HENDERSON..July 18, 1899
Draftsman Conn. River Bridge and Highway District, Hartford, Conn.

ALBERT B. HILL...Jan. 9, 1900
Civil and Consulting Engineer, New Haven, Conn.

FRANK N. HOYT..July 18, 1899
Civil Engineer Highway Commissioner's Office, Hartford, Conn.

BRADLEY H. HULL...April, 1884
Civil and Hydraulic Engineer, Bridgeport, Conn.

ROBERT S. HULBERT...Jan. 13, 1885
Civil Engineer and Surveyor, West Winsted, Conn.

J. FREDERICK JACKSON...Jan. 9, 1900
City Engineer's Office, New Haven, Conn.

CHARLES M. JARVIS...April, 1884
President Berlin Iron Bridge Co., East Berlin, Conn.

WILLIAM E. JOHNSON..Nov. 29, 1890
Engineer of Hartford Water Works, West Hartford, Conn.

HERBERT C. KEITH..Jan. 9, 1900
Assistant Bridge Engineer N. Y., N. H. & H. R. R., New Haven, Conn.

HENRY J. KELLOGG..April, 1884
First Assistant City Engineer, New Haven, Conn.

CASSIUS W. KELLY .... Jan. 9, 1900
City Engineer, New Haven, Conn.

RICHARD S. KIRBY .... March 30, 1900
Civil Engineer, Port Chester, N. Y.

HERBERT M. KNIGHT .... Jan. 9, 1900
Constructing Engineer of the Continental Compressed Air Co., Norwich, Conn.

J. W. KNOWLTON .... Jan. 11, 1887
Civil Engineer, Bridgeport, Conn.

FREDERICK W. LAFORGE .... Jan. 13, 1885
Civil Engineer on U. S. Government Fortifications, Fisher's Island, New York.

EDWIN F. LAWTON .... March 30, 1900
Superintendent Hartford Electric Light Co., Hartford, Conn.

ROBERT P. LEWIS .... Oct. 24, 1895
Secretary Blake & Johnson's, Waterbury, Conn.

FREDERICK P. LEWIS .... Jan. 9, 1900
Assistant General Superintendent S. N. E. Tel Co., New Haven, Conn.

FRED T. LEY .... July 18, 1899
Civil Engineer and Contractor, Springfield, Mass.

HIRAM G. LOOMIS .... April, 1884
Civil Engineer and Surveyor, Hartford, Conn.

FRANK W. LOOMIS .... July 18, 1899
Civil Engineer and Surveyor, Hartford, Conn.

FRANK A. MALONEY .... Jan. 9, 1900
City Engineer's Office, New Haven, Conn.

GEORGE E. MANNING .... Jan. 11, 1898
Civil Engineer, New London, Conn.

THEODORE H. McKENZIE .... April, 1888
Sanitary and Hydraulic Engineer, Southington, Conn.

J. M. McKENZIE .... April, 1884
Civil Engineer and Surveyor, Yalesville, Conn.

JOHN T. McKNIGHT .... May 31, 1893
City Engineer, Rockville, Ellington, Conn.

ALEXANDER D. McLEAN .... Jan. 13, 1885
Civil Engineer and Surveyor, Wallingford, Conn.

CHARLES W. MERRELS .... Jan. 9, 1900
City Engineer's Office, New Haven, Conn.

SHELDON B. MINOR .... Sept. 25, 1886
Civil Engineer, Greenwich, Conn.

ROBERT E. MITCHELL .... Jan. 9, 1900
Civil Engineer and Surveyor, Willimantic, Conn.

WM. HARLEY MOORE .... Jan. 9, 1900
Engineer Bridges N. Y., N. H. & H. R. R., New Haven, Conn.

JOHN P. MURPHY .... July 18, 1899
City Engineer's Office, Hartford, Conn.

PAUL NASH .... Jan. 9, 1900
City Engineer, Stamford, Conn.

EDWARD S. NETTLETON .... Jan. 9, 1900
Civil Engineer, New Haven, Conn.

WILLIAM H. OLMSTED.......Jan. 14, 1890
Civil Engineer and Surveyor, Los Angeles, Cal.

C. HENRY OLMSTED.......July 18, 1899
Civil Engineer and Surveyor, East Hartford, Conn.

FRED H. OSBORNE.......Jan. 9, 1900
City Engineer's Office, New Haven, Conn.

ELIJAH H. OWEN.......March 30, 1900
City Engineer's Office, Hartford, Conn.

SHEPARD B. PALMER.......Jan. 8, 1895
Civil Engineer and Surveyor, Norwich, Conn.

GEORGE E. PALMER.......March 30, 1900
Asst. Engineer N. Y., N. H. & H. R. R., Southport, Conn.

WILLIAM B. PALMER.......Jan. 13, 1885
Civil Engineer and Surveyor, Bridgeport, Conn.

GEORGE A. PARKER.......July 18, 1899
Supt. of Keney Park, Hartford, Conn.

ARTHUR J. PATTON.......Sept. 12, 1889
Civil Engineer and Surveyor, Waterbury, Conn.

ERMON M. PECK.......Jan. 8, 1895
Assistant Engineer Hartford Water Works, West Hartford, Conn.

EDWARD H. PHIPPS.......April, 1884
Pres. and Engineer Conn. Patent Water Pipe Co., New Haven, Conn.

STEPHEN C. PIERSON.......Jan. 13, 1885
Civil Engineer and Surveyor, Meriden, Conn.

JOHN K. PUNDERFORD.......Jan. 9, 1900
Engineer Fair Haven and Westville R. R. Co., New Haven, Conn.

ARTHUR W. RICE.......April, 1884
Prest. Union Mfg. Co., New Britain, Conn.

WALTER H. RICHARDS.......March 30, 1900
Engineer of Water and Sewer Departments, New London, Conn.

WM. LISPENARD ROBB.......Jan. 9, 1900
Prof. of Physics Trinity College and Consulting Engineer Hartford Electric Light Co., Hartford, Conn.

HALBERT G. ROBINSON.......Jan. 11, 1898
Civil Engineer and Surveyor, Hartford, Conn.

GEORGE B. ROGERS.......July 18, 1899
Architect (Crosby & Rogers), Hartford, Conn.

ROBERT W. ROLLINS.......Jan. 9, 1900
General Manager Hartford Electric Light Co., Hartford, Conn.

ELY M. T. RYDER.......Jan. 9, 1900
Civil Engineer and Surveyor, New Haven, Conn.

RALPH J. SABIN.......April, 1884
Civil Engineer and Surveyor, Pomfret, Conn.

GEORGE H. SAGE.......Jan. 8, 1895
Secy. and Supt. Berlin Iron Bridge Co., East Berlin, Conn.

HUGO SCHAEFER.......March 30, 1900
Master Mechanic Central New England R. R., Hartford, Conn.

H. HILLIARD SMITH.......March 30, 1900
Architect, Hartford, Conn.

WILLIAM G. SMITH..April, 1884
Chief Engineer Albany and Hudson Railway and Power Co., Waterbury, Conn.

THOMAS C. B. SNELL..July 18, 1899
Engineer Hartford Street Railway Co., Hartford, Conn.

HENRY SOUTHER..Jan. 10, 1899
Metallurgist and Analytic Chemist, Hartford, Conn.

ALBERT F. SPENCER..April, 1884
Civil Engineer and Surveyor, Bridgeport, Conn.

WALTER T. SPENCER..Jan. 9, 1900
Division Engineer N. Y., N. H. & H. R. R., Guilford, Conn.

A. WILLIAM SPERRY..Jan. 9, 1900
Civil Engineer and Surveyor, New Haven, Conn.

WILLIAM F. STEFFENS..March 30, 1900
Bridge Department N. Y., N. H. & H. R. R., New Haven, Conn.

RAYMOND FRENCH STODDARD..Jan. 9, 1900
Civil Engineer with N. Y., N. H. & H. R. R., Milford, Conn.

EDWARD M. STONE..July 18, 1899
With H. A. Wolcott, Hartford, Conn.

HARRY A. STORRS..July 18, 1899
Asst. U. S. Engineer, New London, Conn.

HUGH B. TABOR..Jan. 10, 1899
With E. P. Augur, Middletown, Conn.

LUCIAN A. TAYLOR..June, 1887
Civil Engineer and Contractor, Boston, Mass.

EDWARD C. TERRY..March 30, 1900
Civil Engineer, Hartford, Conn.

JAMES B. THOMAS..Jan. 9, 1900
Civil Engineer and Surveyor, Hartford, Conn.

JOHN C. TRACY..Jan. 9, 1900
Instructor in Civil Engineering, Yale University, New Haven, Conn.

WALTER E. TRUESDELL..June 11, 1898
Civil Engineer with Tower & Wallace, New York City.

MAX J. UNKELBACH..Jan. 9, 1900
With W. H. Cadwell, New Britain, Conn.

CLARENCE B. VORCE..Jan. 10, 1899
Civil Engineer and Surveyor, Hartford, Conn.

A. R. WADSWORTH..Oct. 27, 1886
Civil Engineer and Surveyor, Farmington, Conn.

EDWARD T. WARD..Jan. 9, 1900
Consulting Engineer, Bridgeport, Conn.

ALBERT L. WASHBURN..Jan. 10, 1899
City Engineer's Office, Hartford, Conn.

HALSEY A. WEAVER..Jan. 12, 1897
Civil Engineer and Surveyor, Woodstock, Conn.

NELSON J. WELTON..April, 1884
Civil and Hydraulic Engineer, Waterbury, Conn.

JOEL M. WHEELER..June, 1887
Civil Engineer and Surveyor, Ansonia, Conn.

ELI WHITNEY..March 30, 1900
President New Haven Water Co., New Haven, Conn.

GEORGE E. WHITNEY Superintendent Stamford Water Co., Stamford, Conn.	March 30, 1900
ERNEST W. WIGGIN Bridge Department N. Y., N. H. & H. R. R., New Haven, Conn.	March 30, 1900
J. K. WILKES Chief Engineer New Rochelle Sewer Commission, New Rochelle, New York.	April, 1884
THEODORE WIRTH Supt. Public Parks, Hartford, Conn.	July 18, 1899
HENRY A. WOLCOTT Mechanical and Civil Engineer, Hartford, Conn.	July 18, 1899
CHARLES LEWIS YOUNG, JR. City Engineer's Office, Hartford, Conn.	Jan. 9, 1900

LIST OF PAST MEMBERS.

HONORARY.

L. E. GURLEY	Troy, New York
L. W. GURLEY	Troy, New York
HENRY T. POTTER	Norwich, Conn.

CONTRIBUTING.

JOHN B. JOHNSON	St. Louis, Mo.
W. C. BRYANT	Waterbury, Conn.
EDWIN H. WILLIAMS	Waterbury, Conn.
WILLIAM BURTON	Norwich, Conn.
FRANK B. DURFEY	Norwich, Conn.
H. L. M. LADD	Norwich, Conn.
J. CARPENTER	Waterbury, Conn.

ACTIVE.

JOHN L. BAKER	Auburn, New York
THOMAS S. BISHOP	New Britain, Conn.
ROLAND D. BARNES	Bristol, Conn.
ALFRED T. BECKWITH	Willimantic, Conn.
J. C. BURGESS	Fall River, Mass.
SYLVANUS BUTLER	New Haven, Conn.
WILLIAM H. BURNETT	Norwich, Conn.
HIRAM COOK	Norwich, Conn.
J. E. DUTTON	Niantic, Conn.
GEORGE C. DUNHAM	New Britain, Conn.
A. B. DRAKE	New Bedford, Mass.
BURR K. FIELD	East Berlin, Conn.
GEORGE W. FULLER	Norwich, Conn.
ROBERT FENTON	Willimantic, Conn.

WILLIAM A. FULLER	Liberty Hill, Conn.
ALBERT S. GLOVER	West Newton, Mass.
EDWIN P GARDNER	Norwich, Conn.
S. C. HEALD	Worcester, Mass.
EDWIN A. HILL	New Haven, Conn.
ARTHUR H. HOWLAND	Boston, Mass.
LAWRENCE B. JENCKES	Manchester, Conn.
E. B. JENNINGS	New London, Conn.
JOHN F. JONES	Hartford, Conn.
G. A. KING	Taunton, Mass.
C. T. LEONARD	Norwalk, Conn.
FRANCES LEONARD	Norwalk, Conn.
GEORGE K. McEWEN	Bridgeport, Conn.
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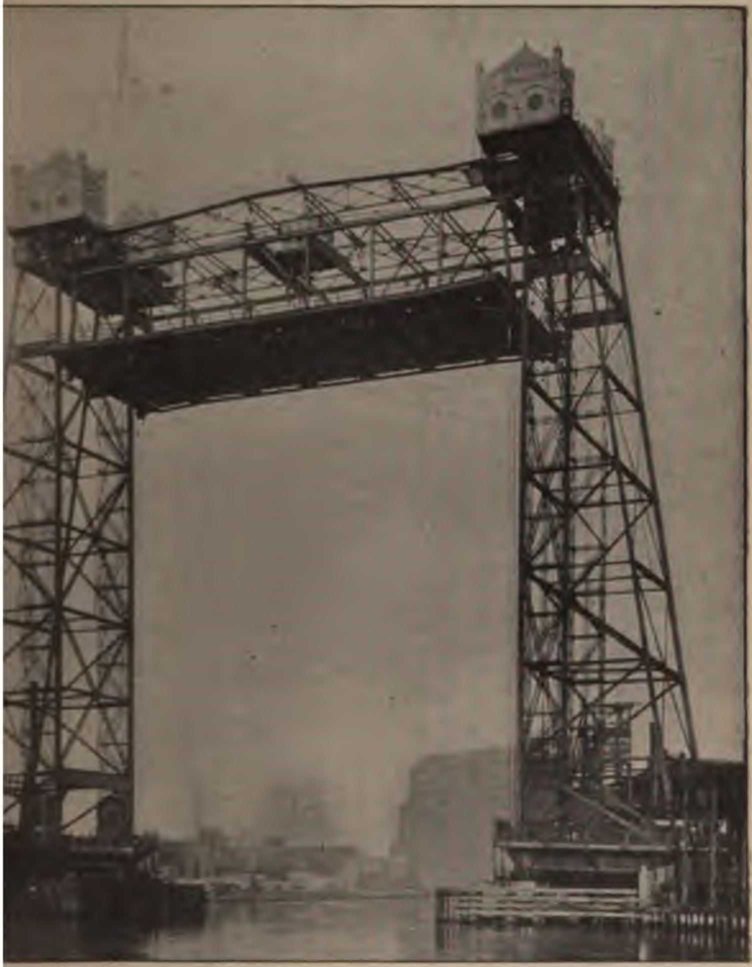

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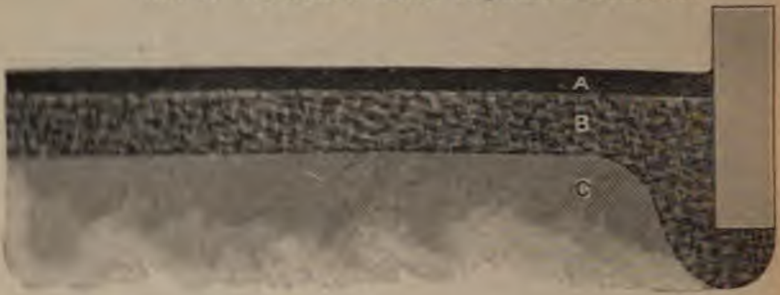

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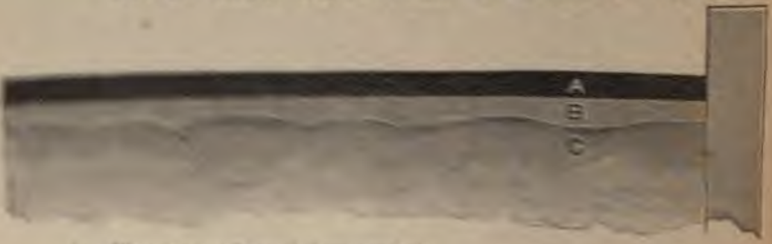

A. Wearing surface of sheet asphalt.
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C. Macadam road.

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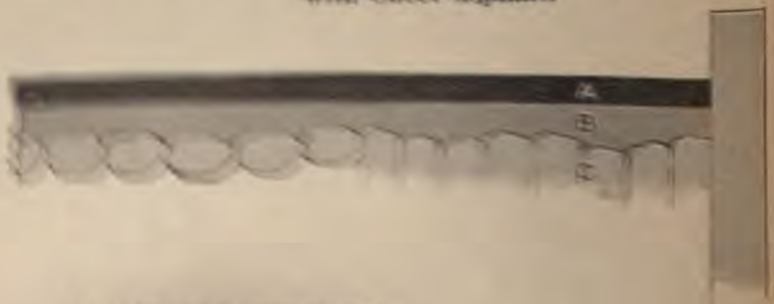

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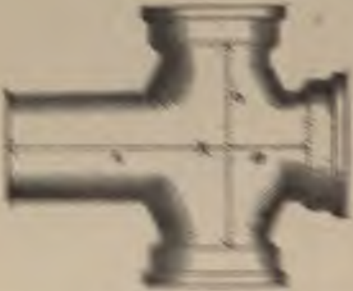

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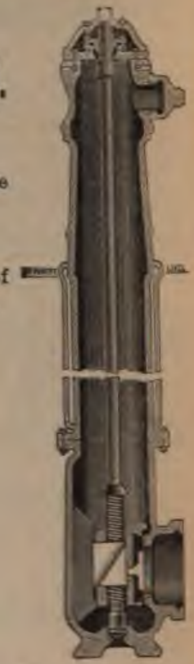

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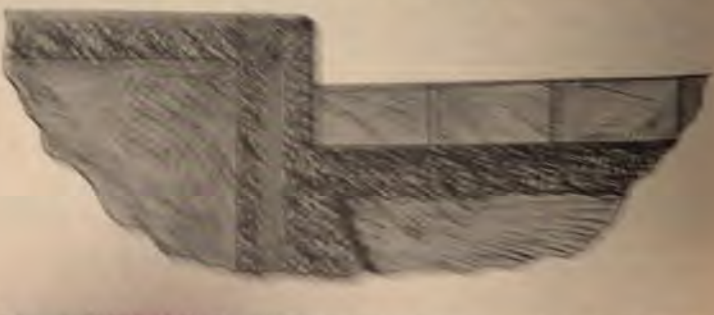

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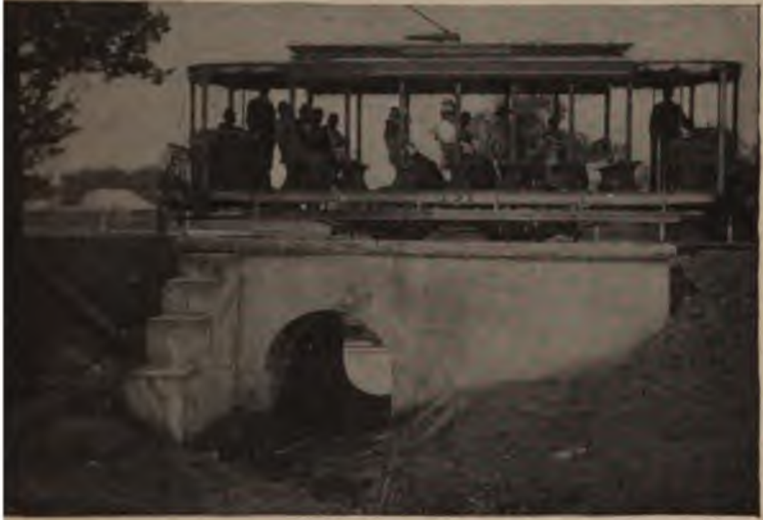
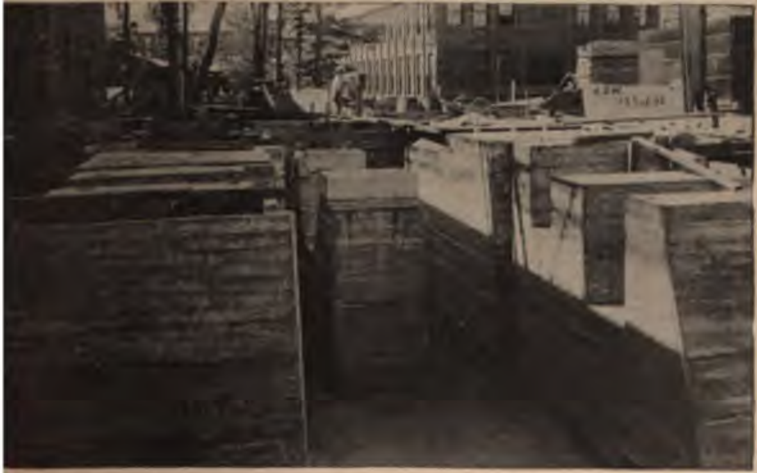


Concrete Arch built for Town of Glastonbury, 1896.



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PROCEEDINGS

—OF THE—

CONNECTICUT

Civil Engineers and Surveyors

ASSOCIATION,

—AT ITS—

SPRING MEETING,

—HELD AT—

NEW HAVEN, CONN., MARCH 30, 1900,

SUMMER MEETING,

—HELD AT—

BRIDGEPORT, CONN., AUG. 14, 1900,

—AND ITS—

SEVENTEENTH ANNUAL MEETING,

—HELD AT—

HARTFORD, CONN. JAN. 8, 1901.

NEW LONDON, CONN.
Press of The Day Publishing Co.
1901.

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B. Hill	1884, 1885
Charles M. Jarvis.	1886
Charles [illegible] Chandler	1887
Charles H. Bunce	1888, 1889
[illegible] W[illegible]	1890
[illegible]	1891, 1892, 1893, 1894
[illegible] Smith	1895, 1896
Robert A. Cairns.	1897, 1898
[illegible]	1899, 1900

PROCEEDINGS
OF THE
SPRING MEETING
OF THE
CONNECTICUT CIVIL ENGINEERS AND SURVEYORS ASSOCIATION,
HELD AT
NEW HAVEN, CONN., MARCH 30, 1900.

The meeting was held at Room 42, North Sheffield Hall, Prospect street, New Haven, Conn.

The meeting was called to order at 10.45 o'clock in the forenoon by President Edwin D. Graves.

The reading of the minutes of the last annual meeting was dispensed with, as they were in the hands of the printer.

The following applications for membership were received and referred to the Committee on Membership. (The President appointed Mr. F. L. Ford to act in the place of Mr. D. E. Bradley, who was absent):

Clifford H. Belden, Raymond F. Bennett, John E. Buddington, Charles F. Chase, Clarence H. Clark, Frederick H. Ellsworth, Frederick J. Easterbrook, Geo. A. French, Richard S. Kirby, Edwin F. Lawton, Elijah H. Owen, George E. Palmer, Walter H. Richards, Hugo Schaeffer, Harry Hilliard Smith, Wm. F. Steffens, Edward C. Terry, George E. Whitney, Eli Whitney, Ernest W. Wiggin.

President Graves requested that the Committee on Badge, recently appointed, endeavor to have some form of badge ready before the time for the summer meeting.

President Graves, on behalf of the Special Committee on Revision of the Constitution, reported progress, and said that they expected to be ready to report to the members by the next meeting, or at least at the next annual meeting.

Mr. George H. Bishop, chairman of the Committee on Water Supply, then presented the report of said committee as follows:

To the President, Officers and Members of the Connecticut Civil Engineers and Surveyors Association:

GENTLEMEN:—The committee on Water Supply, having been called on to report as to the conditions in reference to the water supplies in Connecticut during the year 1899, would respectfully report that the data received from the various water supplies in the State, which are in the Secretary's hands accessible to the members of the Association, indicate the following conditions:

The rainfall for 1897, 54.49 inches, and for 1898, 56.43 inches, in Connecticut, implies that there was ample water supply for those years. In fact those two years show the largest rainfall, I think, that we had had for quite a number of preceding years. The last four months in 1898 show a precipitation of 18.94 inches, which was 30 per cent. more than the normal. The precipitation for the year 1899 was 41.45 inches, or about 86 per cent. of the normal. This varied somewhat at different points in the State for reasons which will hereafter appear, exceptional cases always occurring, as shown on page 7.

The first three months of the year 1899, taking the average precipitation in Connecticut from the above 15 stations, was 15.45 inches, or nearly 30 per cent. in excess of normal. This was followed by nine months when there was but a total of 26 inches, a deficiency of 25 per cent. from normal. The snow during the winter of 1898 and 1899 was unusually heavy, commencing about the 15th of November aud ending in March. This was measured in the rainfall as melted snow, and its effect was to delay the rainfall from reaching the storage basins until it was melted, then suddenly passing it into the reservoirs.

The rainfall of 1900 was: January, 3.94; February, 7.75; making a total of 11.69 inches for the two months, again rising above the normal 46 per cent. for that period.

The heavy precipitation of 1898 and the early part of 1899 apparently filled all the storage reservoirs, and occasioned the wasteage of that portion which the reservoirs could not retain. In one instance, where an accurate registration was made, the

CONNECTICUT RAINFALL.

1899.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Canton	3.17	4.17	6.91	2.03	2.09	6.44	6.83	3.00	4.83	2.50	1.84	2.84	46.65
Colchester	4.61	4.62	6.45	2.74	2.11	2.82	5.38	4.21	3.47	1.21	2.44	2.32	42.38
Cream Hill	3.47	4.13	5.84	1.47	1.75	3.39	6.70	1.11	4.21	1.67	1.59	2.21	37.54
Falls Village	3.20	4.69	5.25	1.23	2.08	3.99	7.09	0.88	4.82	1.63	1.47	2.35	38.68
Hawleyville	3.70	5.46	5.70	1.72	2.13	4.33	4.91	1.19	5.17	1.48	2.10	2.93	41.32
Middletown	4.96	5.08	7.91	1.92	2.67	2.55	5.87	1.72	4.47	2.69	1.53	2.81	44.18
New Haven	4.33	3.39	7.28	1.79	2.52	2.59	4.17	0.65	3.33	1.78	1.89	1.56	35.28
New London	4.02	6.91	7.59	1.45	2.52	2.60	5.29	2.59	4.32	1.87	1.58	1.73	42.57
N. Grosvenordale	4.52	......	6.53	......	1.85	3.81	5.02	1.20	4.40	1.19	2.47	2.21	......
Norwalk	4.28	4.65	6.69	2.11	2.65	3.06	5.91	0.37	4.80	1.42	1.92	2.32	40.17
Southington	4.03	3.78	6.66	1.90	1.75	2.23	5.02	0.45	4.13	2.35	2.15	1.08	36.73
Storrs	3.70	3.97	5.58	2.20	1.25	3.72	5.55	3.27	3.31	1.54	2.10	2.14	39.13
Voluntown	3.85	4.00	7.90	2.61	1.52	2.59	4.58	2.22	8.47	1.43	2.75	2.38	44.18
Waterbury	3.82	4.58	6.75	1.80	2.07	2.32	6.02	1.03	5.30	2.42	1.69	2.81	40.61
Hartford	5.16	5.82	7.69	1.99	2.11	2.87	6.20	1.92	3.60	2.98	2.11	2.01	44.73
Average monthly and yearly	4.05	4.66	6.74	2.00	2.07	3.29	5.64	1.71	4.58	1.88	1.98	2.25	41.45

Connecticut rainfall, 1898: September 2.60 inches, October 6.43 inches, November 6.81 inches, December 2.50 inches.

overflow exceeded the capacity of the storage reservoir, which was about [illegible] gallons by measurement. Probably there were many others of like occurrence, because all report wasteage.

At this point there is a general lack of direct information as to the amount that was practically wasted during the early months of [illegible] excepting that in a general way all report wasteage of from two weeks to four months' duration.

The one report giving details of the wasteage was located in the centre of the State. It had a drainage area of one and one-[illegible] square miles, and the rainfall records at that reservoir show [illegible] inches the first three months [illegible] other Connecticut cities. The [illegible] amounting to 20[illegible]

[illegible] 27th and 28th to the [illegible] the exception of the 11th [illegible] amounting to 169,- [illegible] the wasteage ranged from [illegible] 122 [illegible] that were wasted [illegible] the overflow [illegible] but they [illegible] gallons have [illegible] March up to [illegible]

[illegible] reservoir [illegible] full use, [illegible] that [illegible] was [illegible] is [illegible]

[illegible] months in [illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

[illegible] gallons. The estimate [illegible] gallons [illegible] was about [illegible] million gallons.

The length of time during which [illegible] extended upon various works from two weeks to [illegible] months. There was no substantial gain reported in any of the [illegible] reservoirs during the summer months except in a few [illegible] where there were large proportional water-shed.

The information of most use in determining the effect of the drouth of 1899 on the water works of the [illegible] in tabular form.

For the purpose of comparison [illegible] the number of million gallons [illegible] capacity of each plant [illegible] Fitzgerald's table based [illegible]

The daily consumption [illegible]

[illegible] Effect of Drought of 1899-1900 on Connecticut Water Works

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	7	[illegible]	[illegible]		[illegible]	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	Outside water pumped four months.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4	[illegible]	17		0.3	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5	[illegible]	400		2.1	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6	[illegible]	62	342	8.3	Pressure reduced
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5	0.12	70		.55	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		56	2.66	Consumption reduced to 2½ million gallons daily by requesting care
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	8	1.5	215		2	
[illegible]		4	120			0.5	15		1.2	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6	3	400		4	
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2	15	885		22	
[illegible]	[illegible]	[illegible]	[illegible]	225	15	1.45	500		1.65	
[illegible]		1	[illegible]	7	1				.45	
Norwalk	[illegible]	10	121.5	30.5	6	1.25	100		2.2	
Norwich	20,000	2.4	300	65	5	1.75	53		1.5	Motors and elevators shut off 3 months.
*Portland	3,700	4.5	60	30	1	0.375	60		1.	
*Shelton	4,000	1.5	55	20	2	0.4			.5	Pumped outside water 1,247 hours.
*Southington		2.75	70.5	28	2	1.25	10		.8	
*Southington		3.5	115.5	45	2	1.25			1.1	As enlarged September 1, 1899.
South Manchester		2.4	45	14	1	1.	30		.6	
South Norwalk	7,000	3.25	675	105	8	1.575	40		2.4	
*Stamford	17,500	34.	585	157	2	2.	585		8.5	
Wallingford	8,000	1	350	160	25	.005			.7	Reservoir 9 feet deep, of which 4 feet was drawn.
Waterbury		19.	515	120	1	4.5	280		5.5	

NOTE.—All are Municipal Gravity Works except otherwise noted. *Private ownership. †Partly pumping.

The information obtained from the various works not included in the above table is summarized as follows:

BRANFORD. The works were built in 1899 by the Branford Lighting and Water Company, and consist of a storage reservoir from which water goes by gravity to pumps and is then elevated to a storage reservoir of 2½ million gallons capacity.

BRIDGEPORT. The works are owned by the Bridgeport Hydraulic Company. In addition to the storage reservoirs mentioned in the following table there are three distributing reservoirs. Water is furnished by gravity until the gravity supply is exhausted, when pumping with steam is necessary. The reservoirs were all full from December, 1898, to March, 1899, and were again full by January 1, 1900.

RESERVOIRS.

No.	Area, Acres.	Av. Depth, Feet.	Capacity Mil. Gal.	Drainage Area in Square Miles.
1	170	16	900	12
2	43	17	242	
3	60	16	325	
4	8	10	25	3
5	15	6	30	
6	65	14	300	
7	40	14	189	20
8	45	16	240	
9	46	13	200	

BRISTOL. The works are owned by the Bristol Water Company and consist of two storage reservoirs of 100 million gallons and 55 million gallons capacity, each having a drainage area of about one-half a square mile, and a distributing reservoir of 2 million gallons supplied from Poland Brook, having a watershed of several square miles, through a pipe having a daily capacity of 2½ million gallons. The estimated population of the whole town is 9,000.

DANBURY. There are two storage reservoirs with areas of 35 and 70 acres and two distributing reservoirs of 10 acres each. The reservoirs have drainage areas of 200, 700, 400 and 100 acres respectively. Water was pumped into the pipes from Bogg's Stream during September, October, November and December, 1899. During this time the pressure was reduced.

EAST HARTFORD. The works are owned by the East Hartford Water Company and were built in 1892. Water is taken from a brook through a settling basin about 2½ feet deep with an area of about 4 acres. During the driest weather the full flow of the brook was used, allowing little or no opportunity for settling. The estimated population supplied is 5,000. During the driest weather some customers were not supplied.

FARMINGTON. The works are owned by the Farmington Water Company and were built in 1881.

GREENWICH. The works are owned by the Greenwich Water Company and were built in 1880. Reservoir No. 1 is on Horse Neck Brook and has an area of 70 acres, capacity of 300 million gallons and a drainage area of 1¾ square miles. Reservoir No. 2 is on West Brother Brook. Its area is 90 acres, capacity 325 million gallons and watershed 1 square mile.

HARTFORD. A Venturi Meter is used on one of the mains, and from 11 observations made from March 1, 1899, to March 1, 1900, the average consumption was 8,138,620 gallons. November 1, 1898, there was in storage 1,247 million gallons. Water was pumped from the Connecticut River to the amount of 3 million gallons daily from October 18, 1899, to February 8, 1900.

STORAGE RESERVOIRS.

No.	Full.	Area, Acres.	Capacity, Mil. Gal.	Drainage Area in Square Miles.
	1899.			
1	Mch. 25 to Ap.. 23.......	32	145	6.15
2	May 10 to June 14.	44	283	
3	Jan. 9 to May 22.... .	25	145	
5	Mch. 14 to May 1..	32	94	
4	Jan. 19 to May 6	163	601	3.86
6	Jan. 1 to Aug. 5.	141	765	1.82

Two square miles of the watershed of No. 4 is only partly developed.

The rainfall at Reservoir No. 1 was: January, 3.35; February, 2.53; March, 6.10; April, 2.74; May, 2.16; June, 2.52; July, 4.83; August, 0.90; September, 3.53; October, 2.20; November, 2.68; December, 1.42. Total, 34.96.

LAKEVILLE. The works are owned by the Lakeville Water Company and consist of two ponds of 7 acres and ¾ of an acre, with maximum depths of 12 feet and 10 feet, respectively, supplied by a mountain stream and springs fed from two mountain lakes of over 500 acres area each, and a combined watershed of over 15 square miles. About 2,000 people in Lakeville and Salisbury are supplied and there was no scarcity of water last year.

Meriden. The system is gravity except that the water from Reservoir No. 3 is pumped into No. 4, from which it is supplied to the city by gravity. The water from No. 2 is also pumped. Water was pumped from outside sources from November 29, 1899, to February 13, 1900. The rainfall during 1899 at Reservoir No. 1 was 33.51 inches. Rainfall during February, 1900, was 9.2 inches. January 1st the reservoirs were practically empty. The gain in storage in January was 100 million gallons and in February 410 million gallons.

Reservoirs.

No.	Built.	Area in Acres.	Capacity, Mil. Gal.	Drainage in Square Miles.	In Storage December 1, 1898.	Filled.
1	1869	60	357	2.00	280	Apr. 17, 1900
2	1896-7	25	136	1.62	200	March
3	1891	30	132			
4	1891	5	21	0.05	6	

Middletown. There are two reservoirs, No. 1 used for low service only and No. 2 supplying the high service and also a part of the low service through a reducing pressure regulator. The reservoirs are at elevations 169 and 313 feet above Main street. No. 1 was down 20 inches July 8, 1898, and full August 20, 1898. It was full January 1 to April 1, 1899. No water was used from this reservoir from July 22 to October 10, 1899, during which time there was a gain of 6 inches. December 31st this reservoir contained about 102 million gallons. Reservoir No. 2 was down 5 feet 8 inches October 4, 1898, and full November 11, 1898. It was full January 1 to April 8, 1899. From January 27 to April 27, 1899, it is estimated that 280 million gallons was drawn through a 36-inch waste gate. The reservoir was 8 feet 9 inches down October 31, 1899, and January 1, 1900, it contained 110 million gallons.

Reservoirs.

No.	Built.	Area in Acres.	Storage, Mil. Gal.	Drainage Area in Square Miles.
1	1866	72	220	1
2	1897	80	273	2

New Britain. October 5, 1898, the reservoir was down 6 feet [illegible] inches, and January 11th it was down 13 feet 10 inches, when the amount in storage was 400 million gallons. The reservoir was full from December, 1898, to May, 1899, overflowing during this time from nothing to 4 inches in depth over a rollway 32 feet wide.

NEW LONDON. The works were built in 1872 and supply about 18,000 people. The supply is from a natural lake raised 10½ feet by a dam, with outlet 3 feet below original surface. The area of water below the outlet is 87 acres. The lake is from 38 to 50 feet deep below the outlet level in some places. This fact probably improves the quality of the water. The last amount of water in the reservoir in 1898 was 515 million gallons above outlet. It remained full to May 1, 1899, and the overflow between above dates averaged 1½ inches for a width of 25 feet. A rainfall of 5.38 inches July 20 to 27, 1899, increased the storage [illegible] gallons. A rainfall of 4.38 inches September 20 [illegible] million gallons. Lowest [illegible] December 31, 1899, 300 million [illegible] January [illegible]th and by March 10, [illegible] million gallons.

[illegible] watershed is below a level [illegible] nature, probably mate- [illegible] the lake, but as at one [illegible] separates the lake [illegible] there is probably a large [illegible]

[illegible] the New Haven [illegible] the water was pumped [illegible] from Lake Whitney [illegible] when reservoirs were [illegible] pumped as against the [illegible] The rainfall near [illegible] March 7.49. [illegible] August [illegible] Sep- [illegible] December 2.05.

[illegible] supply and serves

RESERVOIRS.

NAME.	Reservoir Full.	Area in Acres.	Capacity, Million Gallons.	Drainage Area in Square Miles.	Least Storage, Jan., 1900, Million Gallons.	Date of which Water was Lowest.	Date of Filling.
Whitney.....	Oct. 22, 1898, to Sept. 10, 1899.	185.	255	37.7	150	Jan. 29, 1900.	Feb. 4, 1900.
Maltby.......	March 10, 1899.	56.2	130	1.	......	Dec. 17, 1899.	Feb. 1, 1900.
Chamberlain. .	Oct. 23, 1898, to May 24, 1899.	34.8	180	4.3	.....	Dec. 16, 1899.	Feb. 12, 1900.
Wintergreen .	Nov. 11, 1898, to May 3, 1899.	44.	130	1.1	15	Jan. 7, 1900.	Mch. 1, 1900.
Bethany......	Nov. 1, 1898, to May 24, 1899.	101.4	611	3.8	.....	Jan. 11, 1900.	Feb. 5, 1900.
Dawson	Oct. 5, 1898, to May 8, 1899.	67.5	200	5.6	120	Jan. 11, 1900.	29" low Mch., 1900
Saltonstall....	Nov. 19, 1898, to Jan 25, 1899.	400.	1310	4.	60.0	. . ..	....

special elevated district Prospect Hill, and through reducing valve connects with the general system. It yields about 1 million gallons per day. The West River gravity system, including Bethany, Chamberlain and Dawson Reservoirs, supplies about 6 million gallons daily.

The Mill River pumping system, including Lake Whitney and the Prospect Hill Reservoirs, gives about 5½ million gallons daily. The Saltonstall pumping system, with Lake Saltonstall and the Fair Haven distributing reservoir, supplies about 2.4 million gallons daily. The Maltby system supplies about 1 million gallons daily.

The least amount of water in storage in 1898 was about 2,000 million gallons. The initial plant was built in 1860–62.

NORWALK. Reservoirs were nearly full the greater part of the year. Water is occasionally purchased of the city of South Norwalk on account of the inability of the 12-inch pipe between the storage and distributing reservoirs to carry sufficient water during times of maximum consumption.

RESERVOIRS.

No.	Area, Acres.	Average Depth in Feet.	Capacity, Million Gallons.
1	24	[illegible]	62
2	14	12 to 15	55
3	[illegible]	[illegible]	4.5

Flash boards are placed on [illegible] the reservoir dams a portion of the year, increasing [illegible] gallons in excess of that given above.

NORWICH. The [illegible] works were built in 1868. The reservoir is situated [illegible] watershed of about 0.8 square miles, and another watershed [illegible] miles is turned into the reservoir through [illegible] The consumption has never been measured [illegible] estimated at from 1,300,000 to [illegible] The least amount of water in storage [illegible] October 12th. The res[illegible] and it remained full [illegible] wasted through pipes and over [illegible] small amount of water in storage, motors and elevators were cut off from November 1, 1899, to February 1, 1900.

Reservoir was lowest January 11, 1900, when it contained about 53 million gallons. The reservoir was full, 350 million gallons, March 8, 1900. The rainfall at the City Hall was: 1898, September 2.42, October 7.03, November 4.51, December 2.08; 1899, January 4.68, February 2.00, March 7.61, April 2.44, May 1.79, June 3.01, July 5.31, August 2.51, September 6.51, October 0.79, November 2.85, December 2.08; 1900, January 3.94, February 5.74.

PORTLAND. The works are owned by the Portland Water Company and were built in 1889. The reservoir was full throughout the season, except when drawn down a little for flushing.

ROCKVILLE. The works are owned by the Rockville Water and Aqueduct Company and supply about 7,000 people. The supply is from Lake Snipsic, having an area of 525 acres and a maximum depth of over 75 feet. Most of the water is supplied by gravity and about a quarter of it is pumped to a standpipe. Lake could be drawn 5 feet 9 inches previous to 1847, when it was raised 10 feet 9 inches. In 1864 it was raised 7 feet, and in 1872, 3 feet 8 inches, making a total height of 26 feet 5 inches. The lake was full from January 1 to May 1, 1899.

SHELTON. The works are owned by the Shelton Water Company. About one-third of the water is used at the factories. Reservoir was full from January 1 to May 1, 1899.

SOUTH NORWALK. A very little water overflowed from reservoirs in the spring of 1900, about the last of May. Water was lowest February 1, 1900, when there was about 30 days' supply. There are two reservoirs of 500 and 163 million gallons capacity, with areas of 150 acres and 15 or 20 acres, and a distributiug reservoir of about 12 million gallons capacity.

STAMFORD. The works are owned by the Stamford Water Company. The bulk of the water is supplied from Mill River, the watershed of which is so large that the reservoirs were drawn down but little. The lowest water was reached Dec. 1, 1899.

RESERVOIRS.

Name.	Area, Acres.	Capacity Mil. Gallons.	Drainage Area Sq. Miles.
Trinity Lake . .	90	450	34
Mad Pond. . . .	45	88	
Cox's Pond.	21.5	42	
Simsbury Pond	[illegible]	5	

WATERBURY. The principal supply is from Wigwam Reservoir having a capacity of 335 million gallons, an area of 60 acres, and watershed of 18 square miles. Least storage in this reservoir in [illegible] was [illegible] million gallons. The older reservoirs still in use are three in number having a combined drainage area of one square mile, a capacity of 180 million gallons and area of 60 acres. The least storage in the old reservoirs is about 60 million gallons.

WILLIMANTIC. The estimated population supplied is 8,500. [illegible] Natchaug River, from which water [illegible] in part by steam power to [illegible] gallons capacity. Water [illegible] and by water 5,580 hours [illegible]

[illegible] 4,500 people. Two [illegible] the Highland, a former [illegible] November 11 to November [illegible] at the former date.

[illegible]	Drainage Sq. Miles.
[illegible]	1
[illegible]	Several.

[illegible] BISHOP,

[illegible] on Water Supply.

Pres. Graves.—Gentlemen: You have heard the report of the Committee on Water Supply, and the subject is now open for discussion. I hope every member of the committee and all other members who are interested in the subject, will take part in the discussion.

Mr. Herbert C. Keith.—Mr. President, I would move that you invite our invited guests to take part in the discussion. The Committee of Arrangements have taken the liberty to ask several of them to do so.

Pres. Graves.—I will be very glad to extend that invitation, and I do, therefore, ask all of the invited guests present to make remarks and to discuss the subject fully and at any length.

DISCUSSION.

Mr. Ely M. T. Ryder.—The conditions here in New Haven are not very unusual, everything being in good shape. We had at least three months' supply at the end of the season, and the supply is drawn from so many sources that there are a great many different ways of utilizing it.

Mr. Wm. E. Johnson.—As probably most of the members in the central part of the State know from the newspaper reports, Hartford suffered fully as much, if not more, than any other city of Connecticut. The water in our reservoirs dropped down to about 300,000,000 gallons, which would be a little over one month's supply for the whole city, at which time the old pumps, which were located in Hartford some 35 years ago, were started to supply the city. Those were run until some time in January, when the engine running the pump broke down and the whole supply of the city was taken again from the reservoirs. At the time this pump was again put in operation, or repaired, the engine replaced by a dynamo, and we then had only seven days' supply of water on hand; but at that time the rains fell to such an extent that our reservoirs began to fill up, and at the present time are practically full, all except one, which is nearly so. The question of a water supply for the city got so serious that there was a system of pumps put in for a supply from the Connecticut River, but it wasn't found necessary to use it, which of course was a great satisfaction to the water consuming public and the water department.

There has been considerable said in the press in Hartford about the enormous waste in Hartford. We have a consumption there of about 125 gallons per capita, and that is considerably in excess of what some of the other cities are giving per capita, but perhaps is not much above the average of daily supplies. The subject of metering the city is under discussion at the present time by the commissioners, and it is quite probable that within a few years meters will be adopted and placed generally throughout the city in all departments.

Mr. George E. Manning.—I do not know that I can add anything to the information that has been given. I was, however, struck, in looking over these reports, by the small proportion of the State that is used as a watershed for water supplies; there are some 1,000 acres in these reports. It seems to me that there is a large proportion of the State still available.

[illegible] Mr. President: There are a couple of [illegible] ask. Perhaps some of the gentlemen [illegible] The first is whether this [illegible] checking the waste in [illegible] the most important [illegible] supply. I think in [illegible] per capita, and some [illegible] There is one other ques- [illegible] change has been [illegible] due to [illegible] using the [illegible] emptied. [illegible] where [illegible] any in- [illegible] These are two [illegible] and [illegible] it. [illegible] asked. I [illegible] it. [illegible] a de- [illegible] due to [illegible] taking he water from the Connecticut River, and it has been very remarkable that such has been the case, but there has been a prevalence of sickness caused at that time, and it may be there are some gentlemen here who can state more definitely the situation and the cause. But from my own impression I am inclined to think it is the substitution of the river water for the water of West Hartford, which is a clear and excellent water, generally. The western part of Hartford has been supplied with West Hartford water, and I think, notwithstanding the very low state of the water, that there has been health in the localities supplied by the West Hartford system. Whereas, in the supply coming from the Connecticut River, in eastern sections of the city, there has been this sickness. In that connection comes in the question of the pollution of the water in the river, which we all know is quite considerable. We have above Hartford, Holyoke, Chicopee, Springfield, Windsor Locks, Warehouse Point, and those places occasion a great deal of filth in the river. The low stage of the river is stated in General Ellis' report on the surface of the river, and I think at its lowest state it is 8,000 cubic feet per second of discharge, and with the volume of sewage that is coming into the river at that time it certainly, for drinking purposes, very materially injures it; but my own impression is that to this cause, rather than the lowness of the water in West Hartford, or any other reservoir, can be attributed the lack of health and cause of zymotic sickness in Hartford. I know this, that those in the immediate vicinity, in that section of the city that have been supplied, you might say with the dregs of the reservoir in West Hartford, which is a pure supply, have been well, nevertheless. There are others here that know more about it.

Mr. Hiram G. Loomis.—I have formed an opinion that the pipes were pretty well filled up with sediment before they commenced pumping from the river; therefore the pipes are not fully flushed out, and when they commenced pumping the river water through the pipes, it gave us all the sediment that had been accumulating there for several months. Also in certain seasons of the year when they were drawing water from the Farmington Reservoir, it has run down through the canal, and that canal takes the watershed from the mountains and highways, and that canal discharges directly into the main distributing pipe, instead of discharging it into the reservoirs, and for that reason I have an impression that our pipes are pretty well filled before they commenced pumping from the river. The Connecticut river used to be considered one of the purest streams, but I see by an examination they have been making lately, they claim it is very bad.

Prof. Barney.—Mr. President: I was told, I would say in that connection, by a chemist who made a great many analyses on the Connecticut River, one of the State chemists, that he never had made an analysis of water in the Connecticut River in recent years that did not show the presence of bacteria, which come from excrement of some sort, either human or animal; not necessarily disease germs. I do not mean that, but simply a harmless bacteria that comes from excrement [illegible], showing that it was more or less contaminated. Such an analysis had never been made without showing [illegible] I [illegible] regard [illegible] ness of the reservoir. I did not mean to [illegible] water [illegible] less sickness. I mean after [illegible] filled them up, that is apt to be [illegible] amount of surface matter that [illegible] One analysis that was made [illegible] perhaps 200 or 300 bac- [illegible] about 2,000, in that [illegible]. Of course, I do not [illegible] showing that there was [illegible] then they settle down [illegible] most disease germs. [illegible] some others that [illegible] water, but they [illegible] the water the [illegible] will live in water I [illegible] experiments I [illegible] had been quiet for [illegible]. In that time they [illegible] other bacteria. [illegible] fever germ [illegible] water. In sewage [illegible] is dead. [illegible] and make it 4,000 subject. The point made by Mr. Barney about the quality of the water from the reservoirs at a low stage, in regard to being affected by the first rains, I think is a point well taken. It seems to me it would be natural to expect that after a reservoir is in a low stage and then we have heavy rains, the number of bacteria in the water, and the pollution generally, would be generally very largely increased. I know of some reservoirs where the water has been analyzed shortly after the reservoir has been cleaned, where the quality at first was not nearly as good as it was previously. Of course, later on it would be very much better. Of course, when the heavy rains come, the pollution and decaying vegetable matter and organic matter of various kinds, in a heavy rain, would be quickly washed into the reservoir. When the reservoir is low the pollution would be very much less than it would be if the reservoir was full, and therefore we would expect that the quality of the water would deteriorate. As to the questions of the last speaker, as to the accurate knowledge upon the quantity of water that is consumed per capita in different places, that is something that we would like to know very much more about than we do at present. I think very few would know very accurately how much water is actually used. Of course, where it is all pumped at pumping stations, they can tell exactly how much water is being pumped, and knowing the population that is using it, we can get at the per capita rate; but on gravity supplies, unless they are metered at the house or through a venturi meter, I don't think any exact knowledge can be given on that point.

Mr. Johnson.—Mr. President: I would say in connection with the statement that I made about the consumption in Hartford, we have a venturi meter placed at the distributing reservoir. It is, unfortunately, so placed that the supply only passes through it a part of the time, it doesn't pass through it continuously. We used that three or four days during the month, in the early part of the month, and usually the same days of the month, and in that way have got an average, although we haven't got the total consumption. Probably our average of the water used is better known than for the population of Hartford and the number of consumers. There is quite a considerable many supplied in the town of West Hartford, which is rapidly increasing, and also in the town of Wethersfield, and all over, I should say, the consumption per capita will give at a certain time in a season of greatest drought, you can tell exactly how much water you can depend upon during another such a season. And as these seasons run in cycles, the last being the lowest one that has been recorded here in New Haven, you can easily tell, if you know the percentage of increase of population, just exactly how long your water supply will last: and this, of course, must all be determined by the exact knowledge of how much water you are using. Now I would like to ask how many engineers in the State are using a venturi meter, or any other meter, to determine how much water they are using, or whether they are [illegible] guessed at approxi- [illegible] what season it would be [illegible] the season in which [illegible] have to make any allow- [illegible] And I would like to ask [illegible] ities are affected by [illegible] way of determining [illegible] In a recent [illegible] papers. [illegible] Richmond. [illegible] quite [illegible] villages [illegible] bacteria per [illegible] water sup- [illegible] 100 or [illegible] in this [illegible] above [illegible] 100. [illegible] filter. [illegible] ran [illegible] for [illegible] ble [illegible] wing [illegible] tions [illegible] this [illegible] that cubic feet per second. This is what he gave as the minimum flow of the Connecticut River, and that could probably be divided by two and come nearer to it.

Mr. Burt.—I am very glad to have the correction made. I would say in that connection just for a minute, that of course when the Connecticut River is at the very lowest stage, there is quite a perceptible flow of the tide. We have a tide at Hartford about 2½ feet in the extreme, which would interfere quite a little with the calculations on the very lowest datum of discharge. I think the 8,000 cubic feet per second is based on a height of about 4, as I remember it. Mr. Chandler has looked into the matter lately and would be a better source of information.

Mr. Chandler.—So far as Norwich is concerned, we have, perhaps, been about as short as anyone except Hartford, and have had to restrict the use of water somewhat in order to feel safe, but have plenty of water again now. The trouble, as Mr. Bishop says, seems to be due to the distribution. I once heard a lawyer ask an engineer on the stand in relation to the effect of a certain amount of rainfall, and he rather dodged the question by referring to distribution. And the lawyer asked him why he didn't arrange the distribution the way it ought to be. But that, so far as I know, engineers haven't been able to do, and consequently the fact that last year, while we had plenty of rainfall for all ordinary purposes for the year, the fact that it was bunched at the beginning of the year and the end of the year, was what cut us short and other people short.

Mr. Marshall.—Mr. Chairman: In looking over these reports and questions I find there is a question here of the amount of water used in million gallons daily. Now I would like to ask what means the people who made the reports used to find out how many gallons a day they were using: that is, whether they used a meter or did it by weirs, or how they did it. because it seems to me that a good deal depends on the exact knowledge of how much water you are using every day, and the only certain way is to either meter it or measure it by weirs. Now, in the driest season, Mr. Fitzgerald gives in his reports of the water quantity on the Sudbury River that 44,000 gallons were available per square mile in a season of greatest drought. Now if you can determine exactly what your streams was lower than the figures I put it at. I believe the population used in that calculation was something a little less than 75,000 that is supplied, and I think that certain papers are claiming that the present population of Hartford is towards 80,000 at the present time.

Pres. Graves.—Does that 75,000 include West Hartford and Wethersfield?

Mr. Johnson.—It did. We divided the average by 75,000 to get the result of the general average.

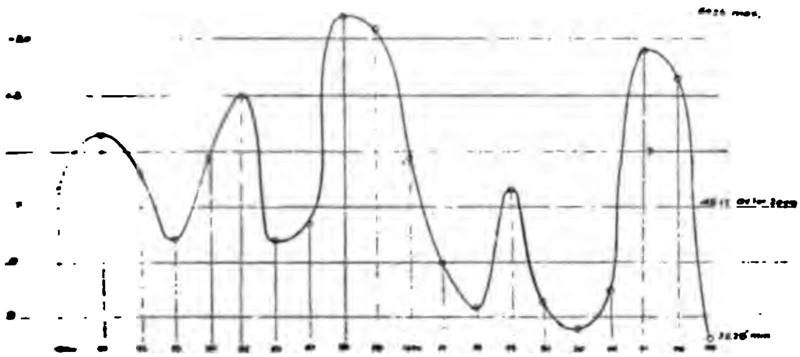
Mr. Burr.—I would like to inquire of Mr. Johnson what the limit of accuracy in the measurement of the flow is.

Mr. Johnson.—Well, the manufacturers of the venturi meter claim that it is a very small per cent. I do not have in mind just the per cent. of inaccuracy. I have at the present time made arrangements to get two meters put on the venturi meter, and in that way get a very accurate pressure reading at the throat and full [illegible], and in that way, probably, for my own satisfaction [illegible] registry. That is a very com- [illegible] gets out of order, and has to [illegible] kind of attention. But, pro- [illegible]. I think that we get a very [illegible]

Mr. [illegible] asked these questions said [illegible] cycles. I wish he would [illegible] that, and how soon we may [illegible]

[illegible] I will answer this last question [illegible] Johnson or anything of that [illegible] because there is no certainty [illegible] periods of high and low [illegible] would be a season of low [illegible] rainfall would be good. [illegible] of rainfall in certain [illegible] would be interested in it [illegible] shows how the rainfall [illegible]

Curve showing percent of rainfall above and below av for 20 years



Now, it may be of some interest to some of the members here to know how the population and water consumption has varied since 1860. Now in 1860 the first system was put in here in New Haven and the supply was not over 6,000,000 gallons per day, according to the pump at Lake Whitney. The population in 1860 was 39,000, increasing to 50,000 in 1870. In 1864 there was another system added to the New Haven works, that is, the Maltby and Wintergreen Lakes, and that increased the capacity about 1,000,000, making 7,000,000 gallons a day available. This went on until 1880, when Lake Saltonstall was added, and in 1880 the population was 62,000 and the supply was 113 gallons per capita. The supply dropped during that period, or the amount used in consumption. The addition of Saltonstall increased the capacity about 3,000,000 gallons. The addition of Saltonstall increased the supply to about 10,000,000 gallons. This lasted until 1889 or 1890, I haven't the exact figures for that, when Lake Dawson was added. That was a watershed of about 14 square miles, and increased the capacity about 80 per cent., and the supply is now estimated at about 18,000,000 gallons a day. The supply in 1890, with 10,000,000 gallons and a population of 85,000 was 117 gallons per capita. The population now, according to the nearest calculation I can make according to the directory and according to the increase before, in 1890, when the last census was taken, brings the population at the present time to about 112,000. And if the supply is 15,000,000 gallons a day, we are using about 134 gallons per capita here. This consumption, of course, varies. In the spring it is lower than it is in the winter, and during the month of February lower than it is in August. In August the maximum consumption is about one-quarter more than the average; that would bring the consumption in August up to about 10,000,000. Now, as the city increases, the question arises where we are to get an increased supply of water or how to cut down the present extravagant use of water so the present supply will last. Now, the population in 1920 I should calculate to be about 208,000 if the rate of increase is about 33 per cent. Of course this is imaginary, for you cannot tell anything about the growth of a city, because the conditions vary so. If the population in 1920 is about 208,000, we shall have to cut down the supply to 75 gallons per capita in order to use the watershed available. That 15,000,000 gallons would be increased to 20,000,000 gallons then. This increase over the present supply may be made by an increase in storage capacity in Whitney, Saltonstall and elsewhere. The Whitney reservoir has a very small storage capacity in comparison to its drainage area, which is about 37 square miles, roughly. And the capacity of the lake is about [illegible] gallons storage. Lake W[illegible] be drawn down very much for the reason that it [illegible] grass and weeds. For that reason the W[illegible] for storage. I present [illegible] in New Haven.

[illegible] of New Haven [illegible] of the various reservoirs, [illegible] daily supply in gallons:

[illegible]

[illegible] 000,000 gallons.

[illegible]

[illegible] gallons.

[illegible] daily capacity about 1,000,-
[illegible] gallons.

[illegible] gallons.

[illegible] about 3,000,000 gallons.

[illegible] gallons.

[illegible] gallons.

pulation, 1890, 85,000.

ily capacity, 10,000,000 gallons.

ily consumption per capita, 117 gallons.

ily supply increased by the addition of the Dawson system to about 18,-000 gallons a day.

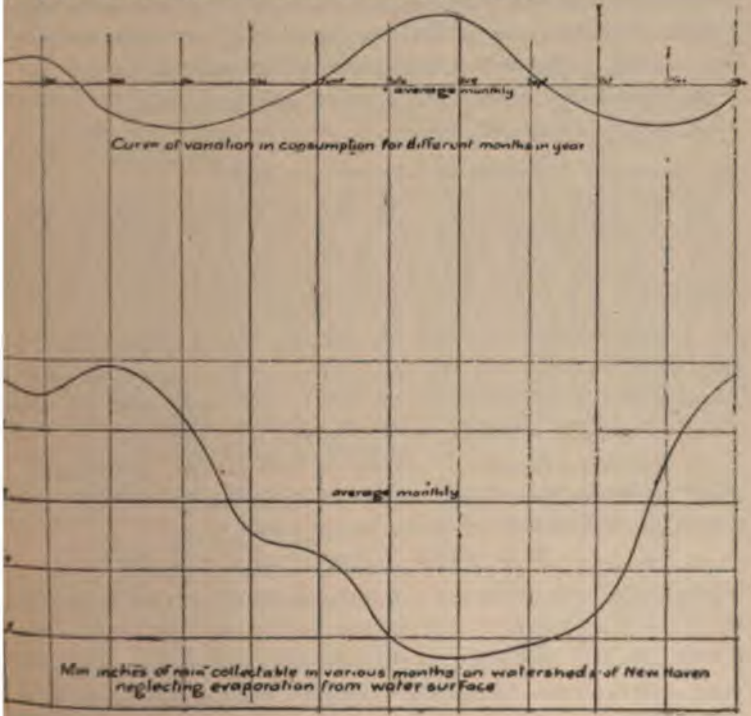
opulation, 1900, estimated, 112,000.

upply, 15,000,000 gallons a day.

aily consumption per capita, 134 gallons.

Question.—I would like to ask for how long a time these observa-ns extended over, how many years.

Mr. Marshall.—The rainfall extends over a period of 20 years, d is taken from the United States observations here in New ven, so the curve is only applicable to New Haven. For another ality you would get a different curve, probably.



The consumption curve is taken from a number of statistics which Fanning has collected, and the percentages of the amount used in different months averaged from those observations which he has taken, and those percentages are given in his book for water supply and engineering.

Question. Was that for one year or more?

Mr. Marshall. Well, that would run over a period of 10 or 15 years. Twenty years is as long a period as you would probably use one water supply, and at the end of 20 years you would need another one. Observations have been taken in Boston which cover a period of 75 years, so if you wish to go back and take a longer time, you can go to Boston records. I have only taken it back to 1880, because I did not think it was worth while to go beyond that. I have the records further back than that.

Mr. Bishop. I did not quite understand the gentleman with reference to calculating the proportion with reference to rainfall. I understood him to say that the amount of water in the streams was yielded in proportion to the amount of rainfall.

Mr. Marshall. Well, it is not in direct proportion.

Mr. Bishop. Well, is there any proportion whatever that you [illegible] with reference to that?

Mr. Marshall. [illegible] the dry weather yield of [illegible] proportion to the rainfall. You [illegible] falls is most of it evap- [illegible] the soil; so you may [illegible] reaches the stream [illegible] earlier months; in [illegible] gets into the stream [illegible] portion of water [illegible] in the month of [illegible] that one month.

[illegible]

[illegible] me entirely. [illegible] a rainfall of 35 [illegible] result as [illegible] in another [illegible] familia [illegible] produce jus

Mr. Marshall.—That is for a wet year, 35 inches would not be worth more than for a dry year. I do not know that there is any proportion that you can establish as to that.

Mr. Richards.—I would like to suggest that the yield varies very largely with the character of the watershed. For instance, if it is a steep, precipitous slope, if the watershed has a steep slope, why then you get very much more water sometimes than you do with a flat watershed. With a small watershed, that is, watersheds 2, 3 or 4 square miles, there is sometimes a very great difference between them, but it never struck me as hardly fair or proper to compare those small watersheds with a large watershed, for instance like that Sudbury River watershed, which is what you might call an average shed, that is, it has some steep slopes and some flat slopes, and some swamp land and some rock land, and it might be said to be an average watershed; whereas very often you get a small watershed of 2 or 3 square miles, which has a maximum neither one way nor the other, so that is a large factor which has to be taken into consideration.

Mr. Marshall.—I understand at certain periods a small watershed may not yield any water at all, because the steams may dry up; whereas, in a stream like the Sudbury River, which is a large stream, you would get some flow all the year; and Mr. Bishop says that during the last year the flow of Sudbury River has been reduced to 19,000 gallons per square mile, instead of 44,000—44,000 has been the lowest before recorded for a period of one month. Of course, for periods extending over more than one month, your proportion rises, you get more watershed.

Mr. Richards.—I have known of an instance of a small watershed which, for a given month, exceeded by 30 per cent. the water that was yielded by the Sudbury River watershed.

Mr. Marshall.—I would like to say, in making some calculations on the amount of water which is available in Lake Saltonstall, the storage capacity of Lake Saltonstall is quite large in comparison with the watershed. The watershed is about 4 square miles, 4 and a fraction, and the area of the lake is 15 per cent. of this, which gives a large storage capacity, and in the driest months the evaporation from Lake Saltonstall would exceed the amount of water which runs into it by several hundred thousand gallons a day. So that the amount of water drawn from the lake must have added to it the amount which has evaporated in order to get the total draft on the lake.

Mr. H. B. Shepard.—Mr. President: I came to listen and to learn, rather than to talk. But there is one phase of this subject which has not been touched upon which I should like to hear discussed, and that is the relative purity of water drawn from the ground, and surface water stored in a reservoir.

Pres. Graves.—Is there any one who can enlighten us on this subject? I presume the gentleman means by artesian wells or water from water sheds ; is that his idea? Supplied from drilled or driven wells?

Mr. Shepard.—Yes, sir.

Mr. Bishop.—That comes under the chemist's department.

Prof. Barney—I do not think that any general comparison can stand between those two statements. It depends entirely on the nature of the reservoir in one case, on the nature of the storage and drainage area, and in the other case, on the strata from which the water comes. Some water from deep wells may be very good; others impregnated more or less with iron or other impurities that require removal. I don't think it is possible to make a general comparison. There is one thing certain about it. The water supplies of this country are, to a very limited extent, filtered, as we know, and those reservoirs which have a large storage capacity have a lower death rate from zymotic diseases. The only salvation is a large storage capacity, and it is the only protection for New Haven and a great many other places. It is impossible to identify the disease germs themselves, and we know, as I said before, that they do not thrive in ordinarily pure water, and they settle down and are very likely to die probably in the neighborhood of three weeks. Now our death rate from typhoid (that is simply taken as a type), runs about 18 or 20 per hundred thousand a year. Now I can not furnish data from driven wells. I have not had a large experience of that kind. I know, as most of you know, from reading, that they very often have to cover water from artesian or driven wells to prevent the sunlight from acting upon it, and it is very often impregnated with mineral salts which have to be removed. I should prefer surface water, myself, provided the drainage area is properly protected—in New England, at least.

Mr. Richards.—I think, Mr. President, that we have failed to distinguish between water that is dangerous and water that is simply disagreeable. Water may be disagreeable and yet not be dangerous. It may even smell bad, and it is bad, and still not be dangerous to life or health. The ground water no doubt, originally, when it is taken from the ground, is purer, on the average, that is, freer from disagreeable odors, etc., than surface water; but after it has stood awhile it may be worse than surface water, and I think, as the gentleman said, each case would have to stand on its own merits.

Prof. Barney.—What I meant by that was, largely, you take well water, a tubular well, and you cannot say, in all cases, it is either good or bad, no more than you can surface water, or water that originally comes from the surface. If it is contaminated when it enters that strata, it may or may not be purified before it reaches the well. If it is water that flows into that strata from miles off, if it is continually followed, it will in time follow the whole strata, so that the effluent will be almost as bad, as to the insoluble impurities, as when it entered, so I fail to see how any general statement of comparison can be made between them.

Mr. Marshall.—I would like to refer this question that this gentleman asked to a report in Massachusetts by the State Board of Health, which was made in 1890, which compares every kind of water supply, either driven well or artesian well; and in this report, which is made by Mr. Stearns, he gives a list of the artesian wells and driven wells, how many of them give a good supply and how many of them fail entirely, and he also goes into several which were drilled in this State, some of which were failures; and in connection with that, the Winchester Arms Company has drilled a well several thousand feet deep, with the idea of obtaining artesian well water, and have not been able to get it, although there is none deeper than that in any other place in the State. In talking with Prof. Parsons, professor of geology here, he said if they had only looked up the stratifications here, they would not have drilled this [illegible] strata, [illegible] to hold the water so [illegible] get any [illegible] water. It is like trying to get water out of [illegible] down into the top of the sieve and taking the water out. The stratification of New Haven is in such a way that the water goes through; you cannot get artesian water around New Haven that is his idea, judging from the formation of the soil in New Haven. And any one wanting to find out about these different well waters, driven wells, tubular wells, and surface waters of any kind, will find the experiments which have been made in Massachusetts on this subject in the special report of 1890.

Mr. Albert B. Hill. I think there is a good deal of popular misapprehension in regard to the purity of subterranean waters. It has been often mentioned that water that comes from beneath the surface, subterranean water, is generally purer than surface water; but on the information that I have been able to get on the subject, I think that, as Prof. Barney says, it depends entirely on the source. In the first place, subterranean waters have to be kept in covered reservoirs if kept for a considerable time, because if it is exposed to the air, there is a light form of vegetable growth formed which is unpleasant to the taste, unless, as in some cases, the water is pumped directly into the wells. In such cases that [illegible] permissible in a supply [illegible] necessary for a large sup- [illegible] some storage for an emer- [illegible] depends entirely upon the [illegible] on Long Island, where [illegible] depth, anywhere [illegible] through fine white sand. [illegible] the majority of cases the [illegible] water. It is likely to [illegible] are very common. [illegible] quantity. So [illegible] water is [illegible] geological [illegible] water.

but to get a large supply is a very different matter. The red rock is of very great thickness. The Winchester Arms Company well went down about 4,000 feet without getting through red rock. They found a little water near the surface, in the upper strata. Beyond that everything was dry. As for the gravel beds in the beds of the stream, the strata here is not thick enough to get a steady supply of large quantity. The sand underneath the city is comparatively shallow. In constructing a sewerage system the water level was frequently penetrated, and the depth is so shallow that the water would be contaminated with whatever pollutes the surface. As far as the amount of water is concerned that can be obtained from artesian wells, or from, I should say, perhaps, driven wells, because artesian wells are impracticable here, but driven wells are successful in a great many places. There are a large number of places in this country and Europe where large quantities of water are obtained from driven wells. But as a general thing I think that subterranean supplies are not as good as good surface water. The water that comes from beneath the surface is simply the surface water that is filtered through the soil. If there is anything in the soil that is likely to pollute it, the water is likely to be polluted. If it comes through fine sand, clean, white sand, the water is good. If it is red sand, with iron, the water will be very unsatisfactory. The trouble with driven well supplies is, that the quantity of water you get at first is not a criterion of what you will get after you have been pumping for some time. Of course, to get a driven well supply, a perfect supply, you must have a large basin filled with gravel, and that is generally full of water after the water has been pumped. Then the yield drops off, and you will only get then the water as fast as Nature supplies it by filtration through the underground streams, so that in many places where they have found the water satisfactory at first, yet, after a few months' pumping, the supply was very small. In some cases they only get from one-third to one-quarter for a regular supply of what would be gathered in the first few months.

Pres. Graves.—I think we would all like to hear from Mr. Baker, if he has any news.

Mr. M. N. Baker, Associate Editor of The Engineering News.

Mr. President and Gentlemen: The subject that we have under discussion is a very important one, one of the most important that comes before engineers for discussion, and one of the most practical. The latter phases of the discussion have brought to mind a few points which I should like to offer to you. It is not at all surprising that in the State of Connecticut, or, in fact, anywhere in New England, where so large a dependence is put upon gravity supplies, that underground water should be held in considerable scorn, you might almost say, although that has hardly been exhibited here. But if you were to formulate or summarize the sources of water supply used throughout the country, you would probably be surprised to find what a very large percentage of the cities and towns of the United States are dependent upon underground sources for their whole supply of water; and you would also be surprised [illegible] in the light of the statements made that it is necessary [illegible] the reservoirs in which the underground water is stored, [illegible] few very few covered reservoirs are in existence; not but [illegible] many instances is very [illegible] But as a matter of fact [illegible] have yet established very [illegible] supplies, or for supplies [illegible] of the relative [illegible] must, in each case, [illegible] of course, [illegible] the ground. It [illegible] to be [illegible] ground into [illegible] that land [illegible] water that falls upon the surface of the ground and percolates into the ground and is subsequently gathered from driven wells, no matter what its condition may have been so far as organic purity is concerned, when it began to penetrate into the ground, if it passes for any considerable distance through the ground, unless the soil is polluted which is a very unlikely thing, since no one chooses that sort of a locality to sink wells which are to be used for water supplies, therefore the water, no matter what its condition, if it goes for any considerable distance through it, is filtered in Nature's own way, which, in many instances, probably in the majority of cases, is probably superior to any artificial appliances or methods of filtration that can be mentioned. Consequently, if you take a careful and exhaustive survey of the literature on the subject, you will find, I think, that the testimony is almost wholly in favor of ground water supplies, in so far as their organic purity is concerned. You will also find that this opinion is backed up by the typhoid statistics of the cities of the world. A number of tables of typhoid statistics have been prepared by Mr. James H. Fuertes in his little book on the quality of water supplies and the relation of quality to disease, and also Mr. Hazen's Filtration of Public Water Supplies, and with regard to the origin of water supply, surface, underground or filtered, you will find that the cities having surface supplies unfiltered have a very much higher death rate on the average than the cities having ground water supplies. When you come to the mineral constitution of the two classes of water, why you are taking up an entirely different question. To make a long story short, each locality and the sources of water available must be considered, just the same as all engineering questions, namely, on its own merits. You cannot lay down hard and fast rules for these things. It is very likely to be the case that ground water supplies will be impregnated as time goes on, with iron in some localities. And a number of interesting filtration plants have been installed in the last few years, especially for the purpose of removing iron from ground waters. There are such plants now in operation at Far Rockaway, N. Y., Superior, Wis., at Atlantic Highlands, Keyport, Red Bank, N. J., the latter being a plant belonging to a real estate company, and in a few other places. Simple filtration is provided after you have proceeded, by aeration, to re-more than [illegible] from the ground waters. I should say roughly, and relying wholly upon my memory, although accurate figures are available, that at least one-third of the public water supplies of the United States are drawn from underground sources. Of course, in New England and parts of New York State and Pennsylvania, and, in fact, all the mountainous region generally, gravity supplies predominate. But throughout a very large part of the West, and scattered through the East, and even through New England, there are a large number of underground sources of supply being drawn upon. There are one or two other points that suggested themselves to me as the discussion went on. It cannot fail to be impressed on the mind of any one who tries to gather information, as your Committee on Water Supply has tried, that the available data for comparative purposes in questions of this sort, are very limited, indeed. For instance, if I understood the report correctly, there was only one of the water works reporting that was able to give, or, at least, did give with any definiteness, any figures regarding the amount of water falling on its shed which runs to waste. Only one place was mentioned where there was, on a gravity supply, any definite means provided for determining the amount of water consumed; and in that case the conditions were such that the venturi meter there placed was not available all the time, owing to the exigency of the local water supply. In short, any one who attempts to do any work on this line finds a most remarkable lack of reliable information for comparative purposes. It is extremely unfortunate that this should be so, because if so many men are going, or attempting to go, over the same ground independently, wearily plodding away, when, [illegible] the results of their experiences. If they only [illegible] what their own experience is, a tre- [illegible] could be saved, and much money [illegible] take this opportunity to [illegible] that have been made for uniform [illegible] other matters. The New [illegible] number of years ago, as some [illegible] into the subject of a [illegible] those schedules that were [illegible] used, by a considerable [illegible] New England, but throughout

ited States, and they have resulted in making it possible to
re the experience of one locality with that of another.
he other day some one was speaking of the cost of pump-
id I was pleased to be able to refer them to statistics on
rticular subject that are found in these reports for a num-
years. I do not know what it has done in the last year
. Some one connected with the Association has taken
rious reports and has tabulated them so that the figures
ectly appreciable.

in all our municipal work it is essential in the future that
ttention should be given to uniform methods of accounting
iform methods of reporting the results of our work. It is
deplorable condition that when anyone attempts to study
n questions that are pressing upon us, of water works, sew-
etc., we have no reliable data. Take the question of muni-
wnership, which I don't propose to go into, only to illus-
he point, it is utterly impossible, lively as that subject is
to bring forward anything conclusive on the subject, be-
there are no reliable figures available showing the results
private and public ownership of water works, gas works,
ectric railways. Now a move has been made to get the
ensus to take up the matter of municipal statistics and to
o it more exhaustively and carefully than has been done
fore; but there is little hope along that line for an immedi-
ion, owing to the fact that the census bureau is restricted
o years to making inquiries regarding population, agricul-
nd manufacturing, and one other phase of the inquiry that
carried out before and is not allowed to take up any other
ts until that work has been completed. So we must wait
902, at least, before anything can be done along that line.
nited States Department of Labor has made a beginning,
municipal engineers and others interested in the subject
, through their Congressmen and others powerful in na-
affairs, endeavor to have the work of the department of
extended along this line of municipal statistics, we would
to add very materially to the figures that would help us all
work. The department did publish last fall a bulletin giv-
e statistics of cities covering several subjects, but limited to

cities with a population of 30,000 and upwards. It is desirable that preparation should be made and that the appropriation should be made larger, so the work can be extended to cover a broader field, and also brought down to a smaller class of cities. Anything the Association can do in the way of appointing a committee, for instance, to confer with committees appointed by other cities, would be a very good thing, I should think. The American Society of Civil Engineers, and the American Society of Municipal Improvement, and the National Municipal League, and a number of other organizations have taken the matter up, and have either appointed, or are expected to appoint, committees to work in harmony with the end in view of securing in some way more reliable municipal statistics.

Prof. Barnes: One point that I just want to speak of that I think should be considered, that in comparing typhoid fever death rates, that the comparison I was speaking of making, was between ground water supply and storage of surface water where they had a reasonable amount of storage for ordinarily 3 or 4 weeks [illegible] I think a comparison of death rate would be [illegible] take all surface supplies and [illegible]

[illegible] that the city of Cam-
[illegible] their water from the
[illegible] the number of typhoid
[illegible] when they took the
[illegible] I think I am right.
[illegible] in Phila-
[illegible] at night. Is

[illegible] statement is true.
[illegible] given
[illegible] supply
[illegible] Delaware
[illegible] the
[illegible] little
[illegible] pumps
[illegible] the

Mr. C. E. Chandler.—Isn't it also the fact that in the case of Lowell they are having so much trouble with lead poisoning. I do not know whether you can filter out that which causes the water to eat the pipe, whether you can get rid of the acid or not.

Mr. Marshall.—How many cities are there that have not had trouble with underground water in some way or other?

Mr. Baker.—That is a question I could not answer off-hand. I would like to say one word, that I did not intend to make a plea for underground water supplies or to say that they were superior to the other, but I was only endeavoring to point out as well as I could in the limits of time some of the facts of the case regarding the extent to which ground water is used and regarding the results that have followed. I know that a large proportion of the European cities filter their supply, but the statistics to which I referred were ground water supplies from European cities where there was no filtration, and in regard also to the effects of slow sand filtration from artificial filter beds, and the filtration that water gets in going through the soil. The whole object of slow sand filtration of water—I am not talking of sewage where it is quite another matter—the slow sand filtration of water is giving the water a chance to percolate through a filtering bed and the bacteria are removed in both cases, water and sewage filtration, not alone by the layer of sand that is spoken of as being on the surface of the bed, but by a similar layer that forms around each minute grain of sand down in the bed. That is, the bacteria in the purification of water and sewage play an important part in filter beds. And in the soil through which the water percolates we all know, who have given the subject attention, that in the upper few inches of soil that there are myriads of bacteria, and you get the same percolation from a bed of soil in one case as you do in the other, notwithstanding there are many objectionable points against ground water. And I should not recommend it off hand, and there have been very many instances where it has been used and disappointing results have followed, especially in quantities where there was any considerable demand for the water. It does have mineral ingredients, and it is necessary, if you are going to consider the water in many cases, although not necessarily in all, that the reservoir should be covered. The fact that a large proportion of ground water supplies has been in small quantities has made it possible to pump direct to the mains. or where the standpipe itself was either covered or the exposed area in proportion to the quantity stored was small. The points that have been made against ground water I think, on the whole here to-day, have been very well taken indeed. But you must bear in mind all the facts of the case and the experience of the country and foreign countries as well.

Mr. Charles E. Ferry.—I think there is a very large percentage of the places in the country that use underground water, judging from the statistics of the American Water Works as Mr. Baker says, probably at least one-third, if the percentage of the people using this water was taken, the percentage would be very different, because most of the places which use underground water are comparatively small places. I haven't the figures, but I should judge that the population, or the people who were served by underground waters would not be more than 10 per cent. perhaps of the total, because most of the places which use large quantities use surface water. Brooklyn is the only very large city which derives any considerable part of its water supply from underground water. Memphis, Charleston and a few other places use underground water, for they are peculiarly situated. They might be almost said to be situated over an underground stream, and they are able to get a reliable quantity of water. But with a few exceptions, perhaps half a dozen cities, I think there are scarcely any of over 60,000 inhabitants who depend upon underground water for their water supply.

Another point which has not been brought out is that where underground water is used, when the wells are forced, the character of the water is sometimes changed. Water may be of good quality and sufficient in quantity, but when the wells are forced the character of the water changes for some reason or other, and more of the organic matter is taken in solution. I would like to ask Mr. Baker if he knows of any place in the country of any considerable size, or any size in fact, which uses underground water where a gravity supply can be easily obtained, or where a pumping supply of fairly good quality can be obtained?

Mr. Baker.—Well, I have no doubt but what there are a number of such places. Available supplies are generally reported on and an engineer is called upon. It depends somewhat on the engineer, of course, whether he will recommend an underground supply or not, but certainly if a surface supply can be obtained by gravity it would naturally be taken in preference to the other. The only reason why there are so few of the cities of large size that are using underground sources is because they now get enough water in that way to suit their needs. In some sections of the country the underground water is as much preferred to the surface water, and the underground water is the purest, and the surface water is just as much to the contrary, as the reverse is true in New England.

Mr. Dunham.—Some one has spoken of Camden, N. J. The city supply of Philadelphia is very bad. I have drawn water from the faucets in Philadelphia in which you could not see the bottom of the glass, and through it also came bugs and all kinds of filth from the Schuylkill, and I think statistics will show that typhoid cases in Philadelphia are greater than all New York and Brooklyn combined. They simply pump water from these rivers up into these reservoirs, and then they flow immediately from the reservoirs down into the sinks and places where they are used. The original idea of the system at Philadelphia was to pump it into these reservoirs and have it settle. Instead of that, the company wasted their filthy lucre in their pockets and did not improve the system, and it has not done so for 30 years. The quantity has been improved, but as for the purity of the water, it is terrible, and the Philadelphia papers for the last few years have been full of that, and it seems criminal negligence on the part of that water company, and all other companies in the United States similar to it.

Mr. Baker.—$12,000,000 has just been appropriated in Philadelphia to filter the water supply of the whole city, and also $3,700,000 for other purposes, making in all nearly $16,000,000 to improve the Philadelphia water supply in the last two or three months. The water could not be represented any worse than it is.

Mr. Getman of Stamford.—I want to ask a question if anybody here has ever had any experience with anchor ice that has been beneficial to them. Now in Stamford we have been bothered great deal with that and the experience has not been of any benefit particularly. We have there three intakes, one to the north one to the east and one to the west, and it does not seem to make any difference in regard to the ice forming, and the company have kept men on watch all through the cold weather, when it freezes at all, to report. And only day before yesterday it came down and the surface of the stream and the screen was almost covered inside of an hour, and then of course it was a good deal of work. Is there anyone here that knows anything about that that can give any remedy for those things?

Mr. Richards.—We have had some experience with anchor ice, but we have not found a remedy yet in our case. Anchor ice is likely to form when the wind is blowing toward the gatehouse and on a cloudy day when there is a sudden fall in the temperature, and that is about as far as we have got. I think if we could move the gatehouse around on the side where the wind came from we would get rid of the anchor ice, but unfortunately we cannot do that, so we have to get rid of it the best way we can. And in one instance we had to let it go down through the pipes or else go without water. But, as the gentleman says, it is a very difficult problem to meet, and we have not solved it yet.

Mr. German.—I would like to state in our case that these three intakes face different points of the compass, and when they are all open it doesn't make any difference which way the wind blows, they will all be covered. That is the point I would like to have illustrated if anybody knows.

Mr. J. W. [illegible] read last week of this same trouble, and [illegible] Mr. H. C. Meyer, I think it is, of [illegible] in speaking of the sub[illegible] so that the velocity of the [illegible] largely, that the smaller [illegible] the surface would not be [illegible] suggested that a beam [illegible] away from the vicinity [illegible] would drive it down [illegible] so that the velocity of the [illegible] down, and so have it on the [illegible]

Mr Gėtman.—I should think that the beam would have to drop down into the water in order to decrease the velocity of the water very much.

Mr. E. W. Bush.—This account that I read did not give any dimensions or anything of the kind. But by throwing this beam out around the intake—of course, the further off you get the barrier the better and the more would be upon it. The anchor ice would stay on the surface of the water instead of being drawn down on to the screen.

Mr. McKenzie.—I read about a week ago about some remedy they put in operation in some city in lower Canada—I think Montreal or Toronto—by means of an electrical current. It was simply a little thing that they made use of by an electrical current placed above the inlet of the pipe, I think. In regard to that matter I would like to state a condition which I found in a new reservoir last winter. We were constructing a reservoir about 25 feet deep, that is, 25 feet to the flood line, and carried it sufficiently high so that there was a natural surface overflow from the lake. We had a heavy ice storm about 6 weeks ago, and the 16-inch pipe outlet from the lake, and quite a large area of ice formed so rapidly as to entirely close the 16-inch pipe and form on the screen and entirely close the screen, so that the water raised up some 16 or 17 feet in the reservoir. And it was two or three days before the water raised sufficiently to carry the anchor ice and allow it to go out of the waste pipe.

Prof. Storrs.—I was about to refer to the instance Mr. McKenzie spoke about of the use of electricity for preventing the stoppage of the inlet pipe by ice. The place where it was being used that I have in mind was in Marquette, Mich. The trouble is not exactly with anchor ice, but what they call the needle ice. When the water is exceedingly cold, then it is that the end of the intake pipe will fill up with these needles of ice, and by surrounding the intake pipe with a coil of wire and sending a current through there, with the limited experience so far, they have found that it would prevent the needles of ice from attaching to the pipe, and in that way prevent their clogging up. I have had occasion to make use of an electric current for thawing out water pipes, and it is very surprising how little heat applied in that way will compel the ice to detach itself from the pipe. And it seems as if that was not so impracticable a scheme as might at first seem to be the case. I do not remember the exact size of the intake pipe of the Marquette works, but it was a number of feet, a very large pipe; and yet the amount of power that it required for that purpose I should judge, although there was no statement made in this record, but from my experience in using electricity for thawing out frozen-up pipes, I should think the amount of power would be comparatively small.

Mr. Chandler.—Mr. President: I wish to say that I believe Mr. Bishop has the reports made to him from the various water works throughout the State, but not all of these water works reported. I therefore offer this motion: Moved, that the Committee on Water Supply be directed to acquire statistics, so far as practicable, from the different cities that are not represented in this report, and shall tabulate all the reports for publication in the annual proceedings. Passed.

Mr. Chandler.—I wish to offer another motion. It will probably be in the neighborhood of a year before the annual report, or the next report is printed, and while we have quite a gathering for this Association, we have a large membership now, and I suppose that not more than a quarter of them are here, and perhaps not that. I would move, therefore, that the Committee or the Secretary be directed to have the report of the Water Committee and the proceedings of this meeting and the address of the afternoon printed and when ready to distribute the copies to members and have a sufficient number of copies for binding with the annual proceedings.

[illegible] Gentlemen, you have heard the motion.

Motion carried.

[illegible] We will now have the report of the Membership Committee.

[illegible] on Membership have examined [illegible] and have approved them all. [illegible] that the Secretary cast a ballot [illegible] these names reported by the Membership Committee.

Motion seconded and voted unanimously.

Recess for lunch until 3 p. m.

The members adjourned in a body to the New Haven House.

AFTERNOON SESSION, 3 P. M.

President Graves.—The hour has already passed when this meeting was announced, so I will call the meeting to order and we will proceed at once to the address.

In making the arrangements for this meeting we were extremely fortunate in being able to secure an address for this afternoon in the line of our general topic of the meeting from an engineer who has made this his special study. His investigation and research and long experience in this line give him a high place among the authorities in this special direction, and we are very fortunate in having with us to address us this afternoon, Mr. Desmond FitzGerald of Boston.

Mr. Desmond FitzGerald, who delivered the address relating to water storage problems, is one of the foremost men in his profession in New England. He was born in Nassau, near Providence, May 20, 1846, and was educated in Providence, R. I., and at Phillips Academy. He began his engineering career as a student in the office of Cushing & Dewitt in Providence. In 1867 he entered the service of the Indianapolis & Vincennes Railroad as axeman, and in three years from that time was advanced to the position of assistant chief engineer of the Cairo & Vincennes road. In 1871 he accepted the position of engineer of the Boston & Albany road. Two years afterwards he was made superintendent of the western division of the Boston Water Works, and remained in that position until the system was absorbed by the Metropolitan Water Works, January 1, 1898. He has designed and constructed some of the largest and most important storage reservoirs built by the city of Boston. He is now engineer of the Sudbury department of the Metropolitan Water Works. He has given special attention to questions concerning the quality of water supplies. He established the first, and for many years the only biological laboratory operated in connection with a water works system in this country. He was the first to design and put in practice the system of stripping reservoir beds of all soil containing organic matter and the shallow flowage treatment now adopted in Massachusetts. He is Chairman of the Topological Survey Commission of Massachusetts and is the Chairman of the Park Commission in Brookline, where he resides, and is a Trustee of the Public Library in that city. He has been the President of the Boston Society of Civil Engineers and of the New England Water Works Association. He is a member of the corporation of the Massachusetts Institute of Technology. He became a member of the American Society of Civil Engineers, September 3, 1884, and was the President of the organization last year. His best known papers and literary productions are: "Temperatures of Lakes," "Flow of Streams and Storage," and "Flow of Water in 48-Inch Pipes."

REMARKS BY MR. DESMOND FITZGERALD.

Illustrated with Stereopticon.

Mr. President and Gentlemen of the Connecticut Civil Engineers and Surveyors Club: I see from the card announcing the programme for the day that I am expected to deliver an address, and I trust that you will not all be disappointed if the address turns out simply to be an informal talk on matters of water supply. A formal address has, I know, the advantages of a more logical arrangement of ideas and a more rhetorical covering, but at the same time informal talks have the advantage for the audience, that the speaker may in an unguarded moment let out facts which may be of interest and which would otherwise remain undisclosed, and the speaker derives the great advantage from such talks that he is not obliged to make a burden of the preparation.

I have had occasion more than once to taste the pleasures of New Haven hospitality and am ready to testify to its spontaneous and hearty character, especially after the warm greeting you have given me to day.

My talk this afternoon is to be on water supply. Before turning to the slides let us take a general view of the subject. In the first place, I have been asked to say a few words in regard to drought which is an interesting subject at the present time, as we have just passed through one of the severest periods of drought that we have had since accurate records have been kept. In [illegible] vicinity of Boston the drought came very near beating the record [illegible] not quite do except in one respect to [illegible] I have no doubt, however, [illegible] New England the record was actually [illegible] estimating the severity of a [illegible] amount of rainfall, the run-off [illegible] exhaustion of reservoirs with given draft. [illegible] development of the supply or the areas of

Desmond FitzGerald,
ineer Sudbury Division, Metropolitan Water Board, Boston, Mass.

oirs or water surfaces will make a difference in the
a recent examination into these matters for the Metro-
ater Board of Massachusetts I found that as far as the
s concerned for the whole year of 1899 we had 37.21
ich is only 8.98 inches less than the average. The
the first three months in the year was abundant, but
arkably small for the rest of the year, giving us the
period of rainfall for these nine months, viz., 21.11
inst 21.82 inches in the driest months of 1883. I found
l a smaller yield of water from the streams recorded dur-
t eight months of the year than for any eight consecu-
s during the past twenty-five years, but owing to diff-
lopment of the storage reservoirs on the water-shed,
rrections for increased evaporation were required, and
e were made it was found that for five consecutive
e yield in 1899 would have been less than any previous
hat for seven, eight or nine month periods, 1880 was a
ater drought. The following table is of interest in this
:—

OF YIELD OF SUDBURY WATERSHED FOR 1899 WITH CORRECTED
YIELDS OF PREVIOUS DRY PERIODS.

iod of Consecutive Months.	Gallons Per Day Per Square Mile.		
	1880.	1883.	1899.
	72,000	61,000	51,000
	86,000	82,000	93,000
	103,000	106,000	111,000
	142,000	206,000	162,000
	183,000	305,000	232,000*

-months period includes the month of January, 1900.

ery dry years are carefully studied by water works en-
cause they furnish the standard for judging the safe
at can be depended upon. In this connection I wish
ize the fact that when a storage system is planned
ld still be enough water left in the reservoir nearest to
ution system at the end of the severest period of
maintain, as far as possible, the purity of the water.
if the reservoirs are entirely emptied, the water from
s must be carried directly to the consumer without any

of those important changes due to storage which are known to act as a safeguard against disease. Where there is a slow passage of water through a reservoir, the organic matter contained is materially reduced.

Where water works are not designed upon the basis of the year of greatest drought, they have suffered from shortness in the supply, and during the past year a number of such instances have come to your notice. Aside from the evils resulting from having the storage reservoirs all drawn out and no water for the city, there is the additional evil of having to pump temporarily from some supply near at hand, and almost always with a delivery of water of greatly inferior quality.

In the construction of storage reservoirs, the city of Boston in 1880 entered into a departure from the old established methods which prevailed before that time. This departure consisted in removing all or nearly all of the organic matter from the land which was to form the bottoms of the reservoirs. The way in which this radical departure was brought about was as follows: When the three original reservoirs were constructed in 1875 on the Sudbury river water-shed, nothing was done to the surface of the ground except to cut down the trees and grub out some of the surface which was particularly full of vegetable matter. As a result, when the reservoirs were filled and the water was used for the supply of the city, the quality seemed to deteriorate rapidly, and at times the odor was so offensive and the organic matter in solution so large that the physicians made a grand row and the daily press was filled with discussions and investigations into the cause of the trouble. The large amount of ammonia or nitrogen, which the water contained, caused in time the most prolific growths of fresh water sponge in the interior of the aqueduct. [illegible] walk for several miles on a soft carpet of sponge [illegible] which covered the invert, without [illegible]. Now a small amount of sponge [illegible] water, and it adds a peculiar [illegible] has once come in contact with [illegible] could not be long tolerated; the [illegible] thousands of stumps removed, and [illegible] were cleaned more or less thoroughly.

In the construction of the new reservoirs a much more comprehensive scheme was planned, and all of the loam, mud and other organic matters were removed and the borders deepened. The result was most satisfactory, so much so that in the construction of the great Wachusett storage reservoir, which will cover six square miles and which is to form an important part of the metropolitan supply, several million dollars are to be spent in removing the soil, and this policy may now be said to have been firmly established in Massachusetts.

The removal of the soil from the bottoms of the reservoirs in the city of Boston has been associated also with the shallow flowage treatment, by which the shallow borders are deepened all around the reservoir so as to provide for not less than eight feet depth of water below high-water mark. In carrying out this scheme of improvement there is excellent opportunity for the display of good judgment in getting the work done as economically as possible, and if the engineer is not very careful in his plans he is liable to spend a very much larger sum of money in this work than is necessary. I have usually selected large shallow areas on the borders of the reservoir where the water would be from one to three or four feet in depth, and have filled these places to a level two feet above high-water mark with the mud and soil taken from the bottoms of the reservoirs and added a good gravel facing with slopes of 3 to 1. This saves a very large amount of stripping and brings the line forming the margin of the reservoir out towards the deeper water. The sections are made to balance in cut and fill so that generally we only have a cut of two or three feet at the toes of the embankments, the large excess of stripping providing the material to fill the shallow embankments to grade. As in other engineering work, careful preliminary studies will result in the saving of a large amount of money.

It is interesting to consider the different methods employed by cities and towns for supplying themselves with water. Besides the method of building storage reservoirs to equalize the run-off from the water-sheds, we have the driven well system, where the wells are connected with a suction main, which has been quite a favorite method in the last few years, and in small towns has been developed with considerable success. Great care should, however, be exercised in adopting this method as the quantity of water which can be obtained in this way is usually comparatively small. It is, of course, necessary to have large areas of sand or gravel to maintain the supply to driven wells, and the absence of these deposits has resulted in the failure of the permanency of the supply from driven wells.

It is remarkable how completely nature does its work of purification in the slow passage of water through the interstices of clean sand or gravel, and unless one has studied the matter of the slow passage of water he will be surprised to learn how many years, under some conditions, it takes for water to traverse a comparatively short distance under ground. In one case recently where I have been called upon to design a system for a town and where the underground supply was limited. I have recommended the following method for increasing the supply of the tubular wells, the valley in which the wells were to be driven was traversed by a brook the water of which, however, was not of good quality. I recommended the stripping of the ground on the borders of the brook, forming small beds, upon which the brook water would be admitted whenever there was a failure in the supply. Wells were to be driven near the corners of these beds and [illegible] that the water of the brook would have to pass [illegible] feet of sand before reaching the wells. [illegible] connected with underground [illegible] human. It is necessary to pay [illegible] chemical constituents of such supplies. [illegible] of iron it makes a great [illegible] change in the character of the iron [illegible] oxygen of the air. It precipi- [illegible] domestic use. As a rule, [illegible] reservoirs. The city of [illegible] trouble with its water [illegible] water with the surface [illegible] gives rise to a most pro- [illegible] are situated upon [illegible] could hardly be a better [illegible] water at small cost. Unfortunately the presence of a large city on the border of a lake seems to be incompatible with the maintenance of the purity of the supply, and large quantities of sewage are discharged into the same water that is used for domestic purposes. Chicago, Cleveland and other cities similarly situated have suffered from these causes. During a professional engagement in Cleveland a few years ago, I found that in the winter when the water was covered with ice the warmer sewage water discharged from the city found its way directly to the inlet of the water supply situated a little more than a mile from the shore by passing over the colder water below, and this shows the danger of supplies so situated. Chicago, as you know, has recently entered into a plan for diverting the sewage through a large canal which has been constructed at an expense of about thirty million dollars.

The excellent quality of the water in large lakes is well known. This is caused by the long time during which the water is held in storage and exposed to the action of the air and sun, and the slow but sure destruction of organic matter. A plan was at one time discussed for supplying Boston with water from Lake Winnepesaukee, which water is of remarkable purity. It is almost as colorless as spring water, and I found during some examinations that even at the depth of one hundred and fifty feet the water was of the same excellent character as that at the surface. In passing around the edges of the lake it will be noticed that large quantities of very highly colored swamp water are constantly passing into it, but as the water remains in the lake for a long period of time the organic matter becomes almost completely destroyed or changed into inorganic matter.

One of the most remarkable cases illustrating the dangers of building small reservoirs on small water-sheds which ever came under my personal observation occurred a few years ago in the village of Windsor, Vermont. Out of a population of one thousand people about one hundred were taken ill with typhoid fever, and of these ten had died at the time of my visit. I found that the water supply consisted of a very small reservoir built upon a brook with about a square mile of water-shed, and that when the reservoir was drawn down the discharges from a typhoid patient had washed into the brook and within a few hours more into the distribution pipes. This supply had been selected by the authorities to avoid the expense of pumping excellent spring water much nearer to the town. There was nothing for me to do but to condemn the entire supply, which was promptly abandoned, and I have heard of no more typhoid epidemics in Windsor.

A great many cities which are situated on the borders of or not far from rivers take their supplies from these sources. Of course, as there is a great variety in the quality of water in rivers in different sections of the country, the treatment must vary with the quality. Western rivers contain a large amount of sediment and require large settling reservoirs, perhaps combined with filtration before the water is fit for use. The city of Philadelphia furnishes an excellent example of the dangers of taking a water supply from a river without filtration. In that city the Schuylkill is pumped almost directly into the distribution pipes with no opportunity for improvement in the quality due to storage, and it is marvellous that the people in a civilized city can stand this kind of water supply for any length of time. The effect of this practice may be realized when we consider that manufacturing and domestic sewage passes into the Schuylkill above the intakes of the Philadelphia works, and that for a very large portion of the year almost the whole flow of the Schuylkill is required to supply the water system, so that no surplus or waste water passes over the dam. This action of the city is doubly open to criticism when we consider that large sums of money have been diverted from the income of the water department to be used in other departments of the city government. Fortunately the community now seems to be aroused to the dangers of its situation and steps are being taken to filter the supply.

I have been asked to say a word in regard to rainfall and yield of streams. The average rainfall near Boston is about 48 inches per year, and it is quite uniformly distributed through the different months on the average, although the fluctuations from this average are large. We should have, therefore, about four inches per month. As one-half of this is lost by evaporation, on the average about twenty-four inches per year are collected in the streams; that is, two feet in depth all over the water-shed, but this amount is again easily reduced one-half to twelve inches for the critical period of drought. The average run-off has been found to be 1.6 cubic feet per second per square mile and the maximum freshet flow about one hundred times this amount. In gallons this becomes a million of gallons per day per square mile for the average run-off, and one hundred millions of gallons per day per square mile for the freshet flow. The month of May is the month of the year which represents the average yield for the year; that is to say, in a long period the flow of a stream during the month of May in Massachusetts represents the average run-off in the average year, and the ordinary flow of the stream may be set down as about 1.1 cubic feet per second per square mile. In a paper on " Rainfall, Flow of Streams and Storage," published in the Transactions of the American Society of Civil Engineers for September, 1892, will be found a very convenient table for ascertaining the storage required to sustain various daily draughts from one square mile of water-shed with various percentages of water surfaces.

General filtration of all supplies used for domestic purposes has not yet become universal or even common in this country, although marked steps towards filtration of waters known to be bad have already been taken. An excellent example of an open filtration system in this country is that recently installed in the city of Albany.

Mr. FitzGerald then gave a brief description of the principal works used for the supply of the city of Boston and the metropolitan district, illustrated by lantern slides. He described the Cochituate and Sudbury aqueducts of the old city of Boston works and the Wachusett aqueduct of the new metropolitan system, and under this head said: There has been a steady advance in the science of the construction of aqueducts in the past few years, almost as much so as in many other branches of water works construction. The Cochituate aqueduct, built in 1848, was 6 feet 4 inches high, by 5 feet wide inside, and was of the shape of an egg and was laid with the large end down. It consisted of two rings of bricks without any other support for the thrust of the arch. The crown naturally settled, and the whole brick work has been very much cracked and in places distorted by the work which it has been called upon to do. It has, however, been kept in good repair and is to-day capable of passing about 20 million gallons daily, its proper quota of water. The fall is only 3 inches to the mile. The Sudbury aqueduct, which will carry about 100 million gallons daily, is of horse-shoe section, 7 feet 8 inches high and 9 feet wide, and is built of brick and stone. The cost was about $220,000 per mile. The fall is one foot to the mile. The new Wachusett aqueduct is built of concrete with the exception of a partial lining of 4 inches of brick work. It has a capacity of 300 million gallons daily and cost only $146,000 per mile, while the cost of the Croton aqueduct of the same capacity was $500,000 per mile. The latter, however, was necessarily an expensive work from the conditions of its situation.

The use of large masses of concrete in engineering work is increasing rapidly, but some caution should be exercised in its employment where it is subjected to great changes in temperature.

Aqueduct bridges in this climate give more or less trouble from the opening and closing of the masonry under temperature changes and accumulations of ice in the spandril spaces of the arches. In the case of the Assabet bridge on the Wachusett aqueduct the plan was adopted of lining the aqueduct with sheet lead enclosed in the brick work, and this has been successful in making the work tight and avoids saturation of the masonry.

Our aqueducts are cleaned once or twice a year so as to aid in maintaining the purity of the water, and also to enable the maximum amount of water to be sent through them. In the case of Sudbury aqueduct careful current meter observations have shown that the flow is diminished about ten per cent. when the brick work is dirty.

The Sudbury and Cochituate water-sheds have a large population, and this has brought about many troubles of a sanitary nature. The evils arising from sewage discharges into the water courses are incident to water supplies in thickly populated neighborhoods, especially where towns and villages situated upon the water-sheds have water supplies of their own. In such cases it is necessary to divert the drainage to some convenient place for treatment outside of the water-sheds. In the case of the water-sheds under discussion the sewage has been either pumped or carried by gravity to gravelly or sandy areas beyond the divides and there discharged upon filter-beds. The towns of Framingham, Natick, and Westborough, and the city of Marlborough are examples of the above sewage disposal plants.

A small force consisting of two inspectors is kept busy upon the water-sheds under the charge of the Metropolitan Water Board, whose duties are to see that no pollutions are allowed in connection with the reservoirs and streams. Frequent chemical and biological analyses are made both by the State Board of Health and by three biologists under the direction of the Water Board, the latter of whom give their whole time to examinations of the waters. These weekly examinations not only show the number and character of the organisms existing in the waters of the reservoirs at various depths, but also give the turbidity, temperature and hot water odors so that the best water can be furnished to the distributing reservoirs.

Examples of the various dams existing upon the Metropolitan Water Works were then thrown upon the screen and their construction described. Particular attention was called to the necessity of building earth dams in thin layers and limiting the amount of water used in the process of consolidation by rolling. The concrete and rubble core walls were described and the methods of plastering the up-stream faces of the concrete core walls with Portland cement to prevent percolation. The speaker said: 'I need not call attention to the necessity for providing ample spillways in connection with earth dams before an audience of engineers. In water-sheds consisting of farming and woodland we generally provide for wasting safely six inches of rainfall collected upon the water-shed in 24 hours and discharging this amount of water at that rate continuously. Many stories are told of the heavy cloud-bursts in the west, but we also have had our heavy rainfalls in the east; one of eleven inches in 24 hours was described by Mr. Francis in the Transactions of the American Society of Civil Engineers.

This slide shows the plan for the future development of the supply and towards which the Metropolitan Water Board and Mr. Stearns, its chief engineer who designed the system, are working. I think it is an excellent plan to have a comprehensive idea of how a city can be supplied in the future, because then, as the works are built, patchwork is avoided; that is; none of the important work is thrown away. In the designing of all public work, even in a small town, I think that this idea should be kept in view. Whatever you do, do it in such a way that it will not some day have to be thrown away, but will form a part of a comprehensive scheme. By adding these successive areas of watershed it has been estimated that we can ultimately secure a capacity of 990,000,000 gallons a day, which is an ample supply for a very large district.

This diagram shows how the daily consumption in a large city grows, and it also gives a little idea of what is used in this country. When we remember that in England or on the continent they are perfectly contented with twenty or thirty gallons per capita, you realize that the water problem in this country becomes a very different matter when you have to supply one hundred gallons a day for each man, woman and child in a large city, and there doesn't seem to be any way of getting that consumption down much below one hundred gallons. In some cities where proper attention is not given to the matter of waste, the daily consumption rises to two hundred gallons per capita. As you increase the size of storage reservoirs the cost of the storage is very apt to decrease. In this large reservoir which Mr. Stearns is now building on the Nashua, with a storage of 63,000,000,000 gallons, the price may come down to $144 per million gallons. The cost per million gallons stored in the Sudbury reservoir was $336.

This slide shows the interior of a large pipe with the concentric rings in the lining. We have made many experiments on the flow of water in cast-iron pipes, and we have found if the co-efficient in the Chezy formula is represented by 130 when the pipe is new, it does not take very many years for it to diminish to 100. I was very much astonished to find that in one of the 36-inch pipes which had been down for only about a year that the co-efficient diminished almost 30 per cent. in that short time. I went into it and found that the only obstruction to the flow of water was a very slight vegetable growth on the inside of the pipe which felt like a greasy scum. It seemed to be more than one-eighth of an inch thick, but that was sufficient to diminish the coefficient materially. In another experiment on pipes which had been down twenty years, all the tubercles were removed and the losses of head due to the tubercles were measured carefully, and they were measured again after we had taken the tubercles off. These experiments have been published, and on a large pipe like that, four feet in diameter, the effect of these tubercles was to reduce the flow about 30 per cent.

Mr. H. J. Kellogg.—Mr. President, I would like to ask this society, and I think I express it also on the part of the city government and of Yale University, to move a vote of thanks to Mr. FitzGerald for his kindness in coming here to deliver this lecture.

Motion voted unanimously.

Mr. FitzGerald.—I am very much obliged to you, gentlemen, I think I ought to thank you for the privilege of coming here and talking to you; I think you are the sufferers. I shall be very happy to answer any questions, Mr. President.

Prof. William Brewer.—I would like to ask to what extent the gentleman thinks the introduction of meters affects the consumption? Isn't that the real way of preventing this increase of waste?

Mr. FitzGerald.—I believe it is. Certainly it seems a reasonable way of distributing water, to measure it, and so to make every man pay in proportion to the quantity that he uses. He generally is then on your side and he will look out that he doesn't use more than is necessary to accomplish his purpose. I don't know why it is, but it is a very difficult thing to accomplish in an American city. Politics have a good deal to do with meters, and I am almost afraid sometimes to recommend meters or to say much about them, but there is no doubt that it is a simple, direct and scientific way to distribute water. I don't believe, however, in a large city, that the general introduction of meters will diminish the total amount of water used as much as we expect. As a rule, the manufacturers, the large consumers and the hotels are all metered. They have in Boston a very excellent way of finding out the amount of water used. The city is divided into a number of divisions, and in each of these a large Deacon meter is placed and connected with the street main. All of the water that feeds any particular section is made to go through this meter by

B. Hill. H. G. Clark. J. B. Thomas. H. G. Loomis. A. B. McLean. C. W. Eddy. E. M. Peck. E. H. Lockwood. Richard S. Kirby. J. C. Tracy. S. E. Barney. Frederick Jackson. H. J. Kellogg. E. B. Harger. T. H. McKenzie. Professor Clark. Chas. M. Crawford. M. C. Parshall. W. K. Brown. H. C. Collins. R. H. Warrin. S. A. Sherwood. F. P. Holden. J. Edward Collins. Edward J. Runger. Charles S. Landers. Harry A. Chase. M. M. Eckhardt. Harry L. Preston. A. B. Alderson. F. J. Easterbrook, J. A. Foulks. H. V. Gifford. W. N. Connor. F. J. Wahlig. Wm. H. Brewer. A. Wm. Sperry. F. H. Osborne. A. S. Hawley.

inations from week to week just where our best water may be found, and we are constantly changing our gates and drawing the water where there is the least vegetable matter, the smallest number of organisms, the least odor when heated, and the best quality from a chemical standpoint. All of these things are considered. It is a great safeguard to a large city and does not cost much.

It was voted unanimously that a vote of thanks be extended to the executive officers of the Sheffield Scientific School for the use of this hall and apparatus for this meeting.

Mr. Herbert C. Keith.—Mr. President and members of the Association: It seems to me that the Association might give profit to itself and save money, and also give to each of the members of the Association not only the papers read before our own Association, but also those read before the other societies if we should unite our Association with these others which form the Association of Engineering Societies. To bring it properly before the Association, I would move that the President and Executive Committee be authorized to look into the matter and if they consider it wise, to unite this Association with the said Association of Engineering Societies.

Mr. C. E. Chandler.—I move as an amendment to Mr. Keith's motion that the President and Executive Committee be authorized to look into the matter and report at a future meeting of this Association. The motion as amended was passed.

Meeting adjourned.

The following members and guests were present: C. B. Vorce, W. H. Richards, Edwin D. Graves, George K. Crandall, E. W. Bush, M. N. Baker, Wm. B. Cochrane, George H. Bishop, Geo. E. Manning, Herbert C. Keith, W. C. Marshall, B. W. McFarland, E. P. Augur, H. B. Tabor, Max J. Unklebach, C. E. Chandler, W. D. Clark, Frank N. Hoyt, Frederick L. Ford, John P. Murphy, Shepard B. Palmer, L. E. Daboll, L. W. Burt, L. H. Burt, J. T. McKnight, John Henderson, Halbert G. Robinson, Major P. Maher, H. G. Shepard, J. K. Punderford, Henry R. Buck, Ely M. T. Ryder, W. E. Johnson, Chas. E. Ferry, Albert

B. Hill, H. G. Clark, J. B. Thomas, H. G. Loomis, A. B. McLean, C. W. Eddy, E. M. Peck, E. H. Lockwood, Richard S. Kirby, J. C. Tracy, S. E. Barney, Frederick Jackson, H. J. Kellogg, E. B. Harger, T. H. McKenzie, Professor Clark, Chas. M. Crawford, M. C. Parshall, W. K. Brown, H. C. Collins, R. H. Warrin, S. A. Sherwood, F. P. Holden, J. Edward Collins, Edward J. Runger, Charles S. Landers, Harry A. Chase, M. M. Eckhardt, Harry L. Preston, A. B. Alderson, F. J. Easterbrook, J. A. Foulks, H. V. Gifford, W. N. Connor, F. J. Wahlig, Wm. H. Brewer, A. Wm. Sperry, F. H. Osborne, A. S. Hawley.

PROCEEDINGS

OF THE

SUMMER MEETING

OF THE

CONNECTICUT CIVIL ENGINEERS AND SURVEYORS ASSOCIATION,

HELD AT

BRIDGEPORT, CONN., AUGUST 14, 1900.

The summer meeting of the Association was held at Bridgeport, Conn., on Tuesday, August 14, 1900.

The business meeting was held at the Atlantic Hotel at 10.30 a. m., President Edwin D. Graves, presiding.

The minutes of the spring meeting held at New Haven, having been printed and sent to the members, the reading of them was dispensed with.

The following applications for membership were received: Luther Harold Burt, Hartford, Conn.; Frank Caum, Hartford, Conn.; Theodore Alden Curtis, Windsor, Conn.; Benjamin F. Hathaway, Stamford, Conn.; William D. Johnson, Hartford, Conn.; William C. Marshall, New Haven, Conn.; Harold A. Parsons, Stamford, Conn.; William B. Reynolds, Waterbury, Conn.; Charles N. Wood, Norwalk, Conn.

No member of the Membership Committee being present, on motion of Mr. George H. Bishop, it was voted that the President appoint a temporary Committee on Membership to act at this meeting.

The President appointed T. H. McKenzie, R. O. Cheney, Jr. and Edward W. Bush.

The Membership Committee made a favorable report on all of the applications and the applicants as named above were declared elected as active members.

The business meeting was then adjourned and the members were taken by steamer to Pleasure Beach, where a social hour was enjoyed, and at 1.30 they sat down to a sumptuous shore dinner at Lehmann's.

The committee, to whom the arrangements for the day's outing had been entrusted, had made bountiful provision for entertainment with vocal and instrumental music, and it was much regretted by them as well as all present that a larger number was not there.

The following members and guests were present: Edwin D. Graves, Hartford; Henry J. Kellogg, New Haven; John K. Punderford, New Haven; Arthur J. Patton, Waterbury; C. W. Eddy, Simsbury; William B. Reynolds, Waterbury; John T. Henderson, Hartford; George H. Bishop, Middletown; Edward T. Ward, Bridgeport; H. E. Carlisle, New Haven; A. R. Wadsworth, Farmington; George K. Crandall, New London; T. H. McKenzie, Southington; R. O. Cheney, Jr., South Manchester; F. A. Maloney, New Haven; J. Frederick Jackson, New Haven; George W. F. Gillette, New Haven; Theodore P. Fordham, Essex; Charles N. Wood, Norwalk; E. W. Bush, Hartford.

PROCEEDINGS

OF THE

SEVENTEENTH ANNUAL MEETING

OF THE

CONNECTICUT CIVIL ENGINEERS AND SURVEYORS ASSOCIATION,

HELD AT

HARTFORD, CONN., JANUARY 8, 1901.

The seventeenth annual meeting of the Association was held in the Council chamber, in the City Hall, at Hartford, Conn., January 8, 1901.

The meeting was called to order at 10.30 o'clock in the forenoon by President Edwin D. Graves.

President Graves stated that he had invited Mayor Harbison to be present to open the meeting, but he had received the following letter, which he read:

MAYOR'S OFFICE,
HARTFORD, CONN., January 7, 1901.

Edwin D. Graves, Esq., President:

Dear Sir:—Your invitation to be present at the seventeenth annual meeting tomorrow morning is to hand, and in reply would say that I have an engagement in Boston and leave for there this afternoon and will not return until tomorrow evening. Under the circumstances I must decline.

Wishing your Association success in the future as in the past and a Happy New Year, I am,

Very truly yours,
ALEXANDER HARBISON, Mayor.

The minutes of the last meeting were read by the Secretary and were approved and ordered printed.

The Secretary then read his annual report as follows:

SECRETARY'S REPORT.

NEW LONDON, CONN., January 8th, 1901.

To the Officers and Members of the Connecticut Civil Engineers and Surveyors Association:

Gentlemen: The proceedings of the sixteenth annual meeting held at Hartford, Conn., January 9th, 1900 have been printed and sent to the members and the associations with which we exchange. The proceedings of the spring meeting held at New Haven, March 30th, 1900 have been printed and sent to our members and a sufficient number retained to be bound with the next annual report.

A summer meeting was held at Bridgeport, Conn., August 14, 1900, a report of which will be printed in the next annual report.

During the past year one contributing member and five active members have been [illegible] from the roll of members and one has been [illegible] to the honorary members.

[illegible] members elected (including the [illegible] members) and 73 active members.

[illegible] honorary and 167 active, [illegible]

[illegible] submitted,

[illegible] Secretary.

[illegible] be accepted and [illegible]

[illegible] as follows

TREASURER'S REPORT.

For the Year ending January 8, 1901.

RANDALL, Treasurer, in account with the Connecticut Engineers and Surveyors Association:

RECEIPTS.

hand January 9, 1900	$595.93	
l for advertisements	408.00	
d for dues	480.00	
l from sale of reports	5.00	
l from sale of dinner tickets	148.50	
		$1,637.43

DISBURSEMENTS.

at Hartford	$ 2.00	
phic reports	79.00	
	647.59	
ypes	170.51	
stationery, etc.	102.98	
and cartage	3.14	
and entertainment at annual and summer eetings	288.05	
leon	12.00	
Crandall, salary as secretary	50.00	
hand January 8th, 1901	282.16	
		$1,637.43

Respectfully submitted,

GEO. K. CRANDALL, Treasurer.

on, Conn., January 8, 1901.

HARTFORD, CONN., January 8, 1901.

o certify that we have examined the accounts of George ll, treasurer, comparing the bills with vouchers for same, em correct.

e also examined the bank book, and find the credit as report to agree with balance in bank.

F. L. FORD,
GEO. H. BISHOP,
A. J. PATTON,
Executive Committee.

It was voted that the report of the Treasurer and Auditing Committee be approved and ordered printed in the annual report.

The Secretary then read a report of the last meeting of the Executive Committee.

HARTFORD, CONN., December 12, 1900.

Upon a call of the President for a meeting of the officers and Executive Committee to make arrangements for the seventeenth annual meeting of this Association the following members met at the office of the President at 2 o'clock in the afternoon: Edwin D. Graves, president; Henry J. Kellogg, vice president; Geo. K. Crandall, secretary; George H. Bishop, Frederick L. Ford and Herbert C. Keith.

After a discussion as to the arrangements for the annual meeting it was voted, that the selection of the place for holding the seventeenth annual meeting of the Association and the arrangements therefor be left to the President with power.

Attest:

GEORGE K. CRANDALL, Secretary.

President Graves stated that Mr. F. L. Ford and Mr. Clarence B. [illegible] making the arrangements for the [illegible].

The [illegible] committees were then presented.

The following applications for active membership in the Association [illegible] the Membership Committee. [illegible] the Membership Committee, it was [illegible] accepted, and that the [illegible] ballot for said applicants. In [illegible] one ballot and the following [illegible] as active members: [illegible] Spencer, Frank [illegible] Noble, Francis H. Old- [illegible] Pike- [illegible] Ingersoll, Jr., Her- [illegible] Hunt, George W. [illegible]

Penfield, George L. Blakeslee, Charles H. Nichols, Will H. Fulton, William E. Bush, John S. Lane, E. LeRoy Lane and Amasa C. Hall.

President Graves presented the name of Desmond FitzGerald of Boston, Mass., for election as an honorary member, and it was referred to the Membership Committee.

After a favorable report from the Membership Committee Mr. Desmond FitzGerald was elected as an honorary member of this Association.

The Association then proceeded to the election of officers. Henry R. Buck and Ermon M. Peck were appointed as tellers.

The following officers were declared elected:

Henry J. Kellogg, New Haven,	President.
Clarence B. Vorce, Hartford,	First Vice President.
Arthur J. Patton, Waterbury,	Second Vice President.
George K. Crandall, New London,	Secretary and Treasurer.
John K. Punderford, New Haven,	Assistant Secretary.

EXECUTIVE COMMITTEE.

Henry J. Kellogg (*ex officio*),	New Haven.
Norman McD. Crawford,	Hartford.
Herbert C. Keith,	New Haven.
Loren E. Daboll,	New London.
J. Frederick Jackson,	New Haven.

MEMBERSHIP COMMITTEE.

Charles E. Chandler,	Norwich.
Henry Souther,	Hartford.
Frank A. Maloney,	New Haven.

Mr. Charles H. Bunce for the committee on the revision of the Constitution and By-Laws appointed at the last annual meeting, presented a draft for a new Constitution and By-Laws, and explained the changes.

It was voted that the Secretary of the Association have the suggestions of this committee printed and sent to every member of the Association, with a blank space after every section, in order that every member may make suggestions as to the changes proposed previous to our next meeting.

The President then read his address as follows:

PRESIDENT'S ADDRESS.

In presenting to you my second annual address, I am going to assume the privilege of a retiring officer who has been intimately connected with the workings of the Association, to point out wherein the effectiveness of the Association might be improved. The officers, committees, and all members to whom any special duty has been assigned, have given their efforts freely and effectively for the good of the Association, and there are also exceptional cases where individual members have given freely of their time and influence, but the great majority seem to feel that they owe nothing to the Association which three dollars per year does not cancel in full. I believe there is no member who would not answer a personal letter, but when Association matters are involved, they are considered too insignificant for reply. To answer letters and circulars, and attend meetings, are as important to the welfare of the Association as to pay dues, and all three are essential to [illegible]

[illegible] attending meetings, we now have a membership [illegible] large and enthusiastic meetings, with [illegible] make evening sessions, or [illegible] Some of the small western [illegible] membership hold two day [illegible] put us to shame. It [illegible] as busy as we are. [illegible] form of address. [illegible] worked up and [illegible] This year I made [illegible] the circular. [illegible] expense [illegible] as well as any [illegible] but I [illegible] and [illegible] until it [illegible] which are at all [illegible] with me that [illegible] harm- [illegible] every member is absolutely necessary. Your officers can prepare circulars and do the work of the Association, but it becomes the duty of every member to fill out and return the circular. On December 8th we sent out to our 175 members a blank, asking for information on several lines of work. With this circular was a stamped and addressed envelope for reply. Up to the present time, twenty-eight replies have been received, and the excellence of most of them proves the practicability of the idea, and points more plainly than anything I can say to the utter negligence of over eighty per cent. of the members. This cannot be attributed to pressure of business or lack of time, as is abundantly proven by the fact that some of the most complete and detailed reports come from men who are busily engaged and whose time is fully taken up by the many branches of their work. It can only be attributed to a neglect or lack of appreciation of the plain duty of the members of this Association.

The intention is to send all the information contained in the replies to this circular referring to one subject to the chairman of the committee on that subject, and include it in the report of that committee in our annual publication.

Each member of a committee is chosen for his supposed fitness for the position, and the reports will each be interesting and valuable if the members of the committee contribute from their own observation alone, making if you please a series of five minute papers on the several subjects. I have had frequent requests from chairmen of committees in reference to sending out special circulars, and have invariably advised them against doing so, stating further that the committee report should be made up from the personal observation and practice of the individual members who are on the committee. With one or two exceptions, this suggestion has been followed, and I think there will be no question in the minds of the members present, after hearing the interesting and valuable reports which have already been made by these committees, that the omission of statistics is not detrimental to the interest of the meeting. I believe there is no member of this Association who would be willing to admit that he cannot in a year's practice find enough material to entertain the meeting for the length of time necessary to make a committee report, without recourse to the expensive and unsatisfactiry expedient of special circulars. There is a feeling that in sending out circulars some other person may furnish the information for your report, but experience will prove that you will finally have to make up your own report from about the same information as was in your hands before sending the circular.

There seems to be a prevailing modesty or fear that work which might profitably be described in short papers is not of sufficient importance to interest a meeting; that you must have something large and intricate to be worth describing. This may be true to a certain extent as regards meetings to visit work in progress, but the small papers carefully worked out in detail, which can be discussed by members without previous preparation, are the ones which make meetings interesting and profitable. The small and apparently insignificant details of construction determine the difference between good and poor design, and descriptions and illustrations of these details will serve to bring out extemporaneous discussion, where great subjects cannot be discussed without previous preparation, which our present method of conducting meetings does not allow.

W[illegible] easy to secure sufficient material for a day's meeting. W[illegible] have secured a willing con- [illegible] a valuable paper and all appre- [illegible] are any number of members [illegible] volunteer to entertain [illegible] the duty of the committee of [illegible] and arrange matter offered [illegible] in order to fill out a [illegible] experienced you may be. [illegible] a paper for the Asso- [illegible] you personally receive [illegible] some good, we as [illegible] receives the reward. [illegible] to receive advance [illegible] each meeting, thus allowing time for the preparation of discussion by those interested in the line of the paper.

Since our last annual meeting, we have held two meetings, one at New Haven on March 30th, which was well attended and we were very profitably and pleasantly entertained by the address of Mr. Desmond FitzGerald of Boston, which served to bring out about seventy-five members. In response to a circular in regard to a summer meeting, a general sentiment was expressed for a meeting at the shore which should be a social affair, providing purely a day's outing. This meeting was arranged at Bridgeport on the 14th day of August with the dinner at a shore resort nearby, and while the postal card replies led us to believe that such a meeting would be acceptable and that the attendance would be at least up to the ordinary number, there were present some eighteen or twenty of the faithful who seemed to enjoy a pleasant day, but the lack of a general attendance was too serious a drawback to be overcome by any possible arrangement which could be made.

This being the first meeting in the twentieth century, it seems that a brief record of the organization and development of this Association might properly be presented, and I wish to state that I have secured and bound a complete file of our proceedings, which can be consulted at any time by any member who is interested in the history of the Association.

We were organized at Bridgeport, Connecticut, January 15th, 1884, which meeting was attended by eighteen engineers and surveyors. This seems to have been the most active year in point of meetings in our whole history, for they held four meetings with an average attendance of over sixty per cent. of the membership. On January 13th, 1885, the annual meeting was held at New Haven, with thirty-three members present out of a total membership of fifty-nine. Meetings were held in April and September of '85, both well attended. The membership in 1890 had increased to eighty, a gain of about twenty-one members in six years. The Association substantially stood still in point of membership for nine years, for on January 10th, 1899, the reports showed that we still had a total membership of eighty, comprising six honorary, one contributing, and seventy-three active members. Today, including the members elected at this meeting, we have a membership of seven honorary and 192 active members. That this growth has been accompanied by increased expenditures and more liberal provision in all our arrangements is clearly shown by the Treasurer's reports. We have, however, a sufficient balance to assure ample funds for all our needs, and as it is not the province of this Association to be conducted for the accumulation of money, it seems to me that the expenditures have all served to advance the interests of the Association. By the generous response of our friends in the form of advertisements, the publication of the annual report has been made to pay for itself, even with the great additional expense involved in the recent issue. With our present membership roll, we shall have ample funds for all our uses, and soon shall have money to devote to some special use, which will be of profit to ourselves and to the engineering fraternity in general. What form this may take is not at present clear, although I have an idea of some suggestions in this line which may be presented at a future meeting.

I am extremely gratified at your choice of President for the coming year, and wish to remind you of a fact of which some of you may possibly not be aware, that Mr Kellogg is of the rare vintage of '84, was one of the original founders of this Association, and by his valuable help and interest has aided the Association throughout its existence, and he fully merits the honor which you have today conferred upon him.

In closing, I wish to express my deep appreciation of the honor which you have conferred upon me in twice electing me to the office of President of this Association. I trust that you will be [illegible] mistakes and remember only the good things, [illegible] the support and encouragement [illegible]

M[illegible] this city of the Assistant S[illegible] the President's clerk. Miss [illegible] that the sum of $25 be ap[illegible] services. So voted.

[illegible] the report of the special com[illegible] at the last annual meeting.

his report was presented by Mr. Wadsworth chairman of the mittee, and discussed by the members.

he meeting then adjourned for dinner.

he members were taken by special electric cars, gratuitously vided by the Hartford Street Railway Company, to the club se of the Hartford Golf Club. Here a bountiful dinner was ad and eighty-four members and guests partook of the same.

t 3.45 p. m. the meeting was called to order in the reception m of the club house where the program of the day was continued.

n motion of Mr. C. H. Bunce it was voted that the committee filing maps and plans be continued, with instructions to watch matter this winter in the General Assembly and represent the ociation when the matter comes up for action.

Mr. Bunce—As there is not sufficient time at this meeting for a cussion on the several committee reports, would it not be a good a to have these papers printed before the next meeting at which e they could be brought up in case any member desires to dis- s them.

It was voted that the reports be printed in the proceedings and t out to the members as soon as possible in order to give them opportunity to look over these papers and discuss them at the xt meeting if they so desire.

Mr. Punderford—I would like to make a suggestion but I would e an expression of opinion before I make it. I came here today th a number of questions up my sleeve; practical questions which ave run up against in my work. I proposed asking the members at their experience was in dealing with them and I have had no portunity to ask them or discuss them with the members. I lieve that we would receive much more benefit from discussing se matters than by hearing papers. I would like to ask why this nnot be? Possibly we may not be able to devote two days yet, t can we not at these meetings in the forenoon proceed with the me program as we had this morning, then adjourn to take lunch r an hour, taking it wherever we see fit or convenient. Then et again at 2 o'clock and devote two hours to the questions. I d numerous questions, for instance: Those of you who have used y shape trolley wire other than figure 8 or round, whether you had any squealing. Other difficulties I had met in construction. Devote two hours to an informal discussion, members rising to ask questions that appeal to them in their particular line. Then hear only two papers discussed and then have our banquet for those who could stay in the evening. Some could not possibly stay two days. I believe we could derive a great deal of benefit we do not get when we conduct our meetings as we do today.

President Graves—Are there any more remarks on this subject? We are cramped for time and shall be more so. We have had a great deal of good in our reports.

Mr. Bunce—That was one thing I had in mind when I made my motion. If these reports are printed, at our next meeting where we have no preliminary matters to take up our time, we would be able to take up these papers for discussion.

President Graves—Would it not be possible to hold a spring meeting and devote the time to a discussion of papers without the dinner?

Mr. Bunce—I suggest that these papers be brought up in case any member desires to discuss them.

President Graves—Let us have an expression of opinion without any vote.

Mr. - —It seems to me impossible to do all we attempt at our annual meeting. If we adopt Mr. Punderford's plan we could do a great deal more. Perhaps delay the dinner until 7. The question of topical discussion is adopted by other societies. Various topics may be given to the President during the year and four or five adopted to discuss for ten or fifteen minutes. I should like to see the whole time given to the meeting and cut out the eating in the middle of the day and put it at the end of the day.

President-elect Kellogg—That would suit me personally, but it would be a burden upon people living remote from the place of meeting. Would it not need a portion of two days for that purpose? It would be very pleasant for a number of us who could attend [illegible] day as we would get the benefit of the discussion. The [illegible] so that no one could get home after the banquet. If that is desired it should be discussed now to give those of us who are coming in today an idea of their wishes in the matter.

President Graves—You are discriminating between a spring meeting and an annual meeting where we have an election of officers.

Mr. Keith—I like a part of the suggestions of the President. A round table discussion is of more benefit than papers describing particular works even though they may be of practical interest to certain members. When we are having the reports of various committees it would be a natural thing to have round table discussion on these subjects on which the committees are making their reports. The meeting could shape its own action, asking questions on any particular branch of the subject in which it was interested. It seems to me it would be of more practical value than the reading of papers. I would second a motion of this kind for the annual meeting.

Mr. Bunce—I would make a motion in view of these suggestions that this matter be referred to the Executive Committee for their consideration and suggestion. They have received the opinions of quite a number of the members.

Mr. Vorce—Should not this be referred to the Committee on the Constitution?

Mr. Bunce—The report of the Committee on the Constitution has been accepted and the committee discharged. I think the Executive Committee should take it up. So voted.

The following papers were then read:

"The New Electrical Subway of New Britain." Paper read by F. H. Oldershaw, City Engineer of New Britain.

"The East Hartford Sewage System," by C. Henry Olmstead, Engineer, East Hartford.

"The Storm Water Problem of Hartford," by Frederick L. Ford of Hartford, Conn.

"The Time Element in Laborers' Work;" by George A. Parker, Superintendent, Keney Park, Hartford.

Mr. Bunce—I move that we pass a vote of thanks to the Hartford Street Railway Company for their courtesy in providing special cars free of expense to bring us out here. So voted.

Mr. Bunce—I move that the President of the Association be authorized to appoint the committees on the various subjects into which our work is divided. Voted.

Partial list of the members and guests present :—

Edwin D. Graves, Hartford; George H. Frost of the Engineering News, New York City; H. A. Storrs, New London; C. H. Bunce, Hartford; C. B. Vorce, Hartford; W. E. Johnson, Hartford; E. M. Peck, Hartford; William B. Reynolds, Waterbury; H. E. Carlisle, New Haven; D. C. Potter, Farmington; George E. Manning, New London; Arthur A. Adams, Springfield; J. T. McKnight, Ellington; H. C. Keith, New Haven; A. J. Patton, Waterbury; T. C. B. Snell, Hartford; C. L. Young, Jr., Hartford; N. C. Spencer, Hartford; C. H. Belden, Hartford; Joseph Booths, Hartford; C. H. Slocum, Hartford; A. B. Alderson, Hartford; F. L. Ford, Hartford; Edward J. Noble, Hartford; Christopher M. Gallup, Hartford; John T. Henderson, Hartford; Roscoe N. Clark, Hartford; Charles M. Crawford, Hartford; G. A. Parker, Hartford; M. C. Hamilton, Hartford; Harold A. Parsons, Stamford; Henry R. Buck, Hartford; C. Henry Olmsted, East Hartford; Theodore Wirth, Hartford; Harry B. Snell, Hartford; W. E. Bush, New Haven; Richard O. Cheney, Jr., South Manchester; Raymond F. Stoddard, Milford; Charles E. Chandler, Norwich; John F. Sevin, Norwich; H. G. Clark, Hartford; E. P. Augur, Middletown; Theodore Irving Coe, Hartford; H. C. Collins, Springfield; Luther W. Burt, Hartford; E. B. Parsons, Fond du Lac, Wis.; Julius L. Adams, South Manchester; Roswell Atkins, Bristol; Charles E. Beach, West Hartford; Raymond F. Bennett, New Haven; George H. [illegible] M. [illegible]; D. E. Bradley, East Berlin; Frank [illegible], Hartford; George K. Crandall, New London; Courtland S. [illegible], W[illegible]; George W. F. Gillette, New Haven; [illegible] Hartford; J. Frederick Jackson, New Haven; [illegible] Hartford; Hiram G. Loomis, Hartford; [illegible] New Haven; William B. Palmer, Bridgeport; [illegible] New Haven; Henry Souther, Hartford; [illegible] A. B. Wadsworth, Farmington; [illegible] Hartford; Henry A. Wolcott, Hartford; [illegible] Francis H. Oldershaw, New Britain [illegible]

[illegible] following special committees for [illegible]

FIELD WORK.

Frank W. Loomis, Chairman	Hartford
Harry C. Carlisle	New Haven
Courtland R. Darrow	Waterbury

SEWERAGE.

Frederick L. Ford, Chairman	Hartford
William H. Cadwell	New Britain
Charles O. Brown	Danbury

ELECTRIC RAILROADS.

Julius L. Adams, Chairman	South Manchester
A. William Sperry	New Haven
T. C. B. Snell	Hartford

ELECTRIC IMPROVEMENTS.

Prof. William Lispenard Robb, Chairman	Hartford
Col. N. F. Heft	Bridgeport
Harry A. Storrs	New London

LAW.

Charles H. Bunce, Chairman	Hartford
Edwin D. Graves	Hartford
Charles E. Chandler	Norwich

BRIDGES AND STEEL CONSTRUCTION.

Harry C. Collins, Chairman	Springfield, Mass.
Daniel E. Bradley	East Berlin
Ernest W. Wiggin	New Haven

HIGHWAY CONSTRUCTION.

Francis H. Oldershaw, Chairman	New Britain
Ralph M. Wilcox	Portland
Francis N. Hoyt	Hartford
Hugh B. Tabor	Middletown
Harold A. Parsons	Stamford

OFFICE MANAGEMENT.

Theodore I. Coe, Chairman	Hartford
John T. Henderson	Hartford
Benjamin F. Hathaway	Stamford

INSIGNIA.

Henry Souther, Chairman	Hartford
Prof. Samuel E. Barney	New Haven
Algernon B. Alderson	West Hartford

STEAM RAILROADS.

Morrison C. Hamilton, Chairman	Hartford
Charles H. Ewing	Hartford
George E. Palmer	West Haven

MASONRY.

Charles M. Crawford, Chairman	Hartford
Ely M. T. Ryder	New Haven
Charles N. Wood	Norwalk

STREET PAVEMENTS.

Christopher M. Gallup, Chairman	Hartford
Edward T. Ward	Bridgeport
Frederick S. Osborne	New Haven

WATER SUPPLY.

William E. Johnson, Chairman	Hartford
James S. Ha[illegible]	Ansonia
D. S. Brinsmade	Derby
George H. Bishop	Middletown
George E. M[illegible]	New London
William S. C[illegible]	Meriden
[illegible]	Norfolk

REPORT OF COMMITTEE ON FIELD WORK.

To the President and Members of the Connecticut Civil Engineers and Surveyors Association:

Your Committee on Field Work would beg leave to submit the following report: On October 29th, 1900, the President of the Association communicated with the committee through its chairman with regard to making its annual report both interesting and instructive. In accordance with this request the committee started to put itself into communication with every member of the Association by means of a circular letter. This letter contained a request that the recipient send to the committee such data as would help to make up an interesting and instructive report. Out of the one hundred and twenty-five (125) letters sent out, the committee have received just three replies, two of which contained regrets at their inability to furnish any material for our report, and the third a very instructive and novel method of tunneling which has been incorporated into the report as it was received.

No attempt has been made to collect data respecting the number of miles of line and grade given, or number of lots staked out, it being the aim of the committee to obtain from the various members of the Association an account of some method used in the field which perhaps was not in common use, or the description of some instrument which would help the other members of the Association in their practice.

Your committee wish to express their thanks to Mr. James P. Bogart, C. E. of New Haven, for the following description and use to which he has applied the "Water Level." Some time ago he had occasion to contour, with twenty foot curves, about thirty square miles of the country about New Haven, Conn. The plane table was used for making the map. The scale of the map was one ten thousand. All details of the topography were shown on the map.

The map was traced in sections and a section pinned onto a folding sketch board of convenient size. Benches at intervals of about one mile apart were established along the main roads by using an Engineer's Wye level. From these benches levels were run with the water level up and down hill for distances of two or three miles with an error of say one to two feet. The rod used was a square stick, twenty one feet in length. The middle foot was painted black, and the other feet alternately red and white. The target used was a white rag tied around the pole.

The operation of contouring consisted in placing the water level say two hundred feet from a bench and reading the rod. The height of the instrument being thus obtained, the rag was set on the stick at the twenty feet contour that was within the limit of the pole. The pole was then carried along a line of fence till the point was reached where the contour crossed the fence. The distance to some known object on the tracing, as a cross fence, was then paced [illegible] distance was then taken with dividers off from a [illegible] tracing. Any desired number of contour [illegible] when joined together produced [illegible]

[illegible] were kept in mind, and [illegible] trees, or rocks, to aid in [illegible]

[illegible] A light tripod fit- [illegible] The level itself consists [illegible] A piece of gas pipe is [illegible] say three [illegible] a glass tube say six [illegible] The [illegible] is slipped [illegible] turned up. The [illegible] two or three inches of [illegible] or alcohol. [illegible] prevent freez- [illegible] a cork is [illegible] the water from [illegible] out of level. In [illegible] the [illegible] V [illegible]

the water level set the tripod on the ground same as any
strument, and take hold of the spindle and bring the pipe,
t of the wrist, into a nearly horizontal position. Remove
from the tube and the water will come to a level in
tubes. Then stand off about three feet and sight along
f the water in the two tubes. The twenty-one feet stick
by counting up or down from the middle black foot and
g the fractional part of a foot.

ownshend Double Reflecting and Repeating Circle which is
l below is used by the engineering department of the State
h Commission, of which Mr. Charles H. Nichols is the
d to whom your committee is indebted for the following
on.

inciple of the instrument (Figure 1) is that of the sex-
the whole of the circle can be used instead of one-sixth,
e are two index glasses having their corresponding verniers
pposite side of the circle, but with independent motions and
nts. The horizon-glass and telescope-holder are on oppo-
of the bar, also pivoted at the center of the circle and
h a vernier. The circle is graduated from 0° to 720° and
to 180° and 180° to 0°, so the angles may be measured in
rent ways by either right or left motion of the index-glasses
directly from the scale by means of verniers, or by right or
on of the horizon-glass, subtracting the angles read from
double observation of the same angle may be made by
rver, using both index-glasses, or different angles may be
l at the same time, or an angle may be repeated as many
wished, the graduation being continuous. The size of the
ingle angle that can be observed is about that of the best
but by observing the coincidence of reflecting images see-
her by direct vision, angles upward of 240° can be meas-
The application of the above qualities are numerous, as will
by the following enumeration of its possibilities: 1. One
r using the one instrument may measure altitudes of moon
rs and lunar distance without stopping to read. 2. Meas-
ltitudes of three stars; reading angles after observation.
suring two angles simultaneously, locating position by three

point problem when near land. 4. On shore, locating subordinate signals by three-point problem, all by repeating angles, thus replacing the small bureau theodolite. 5. In boat, locating surroundings by three point problem.

It is proposed to add to the present instrument arms similar to those of the three-arm protractor, corresponding to each vernier, so that angles may be transferred from chart to instrument or from instrument to chart, and position located. Parallel plates for leveling have since been attached.

For hydrographic work, where the three-point problem is involved, it would undoubtedly be of great service, especially when fitted as a three arm protractor. In boat expeditions, or for parties engaged in a rough survey when a minimum of weight is a desideratum, it would also be of very great use, and for such work as that mentioned above it would be a valuable addition to an outfit.

HOW TO USE THE INSTRUMENT.

To Measure Angles. Hold the instrument vertically, observing the object as with a sextant (Fig. 2.)

To Measure Horizontal Angles.—Hold the instrument horizontally with the left hand and through the sight A observe 2 through the unsilvered part of the horizon-glass B, grasping [illegible] the corresponding vernier to [illegible] index finger of the same [illegible] index-glass C, and with [illegible] verniers independently [illegible] and with lower [illegible] always be kept in the [illegible] three objects, 1, 2 and 3 [illegible] line in the mirrors [illegible] measurement operate the tan- [illegible]

[illegible] from a member [illegible] only after many hot [illegible] took place at the [illegible] assort and classify the [illegible] their circular letters.

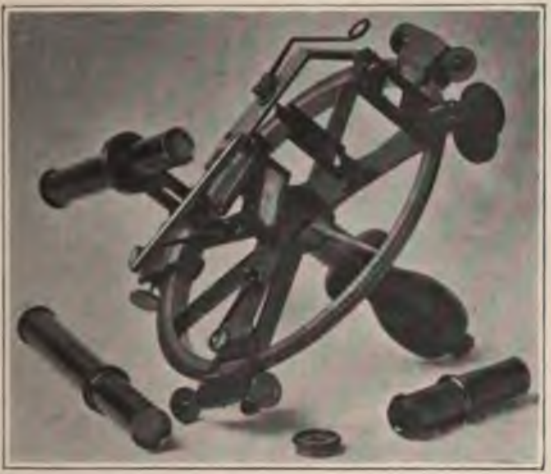
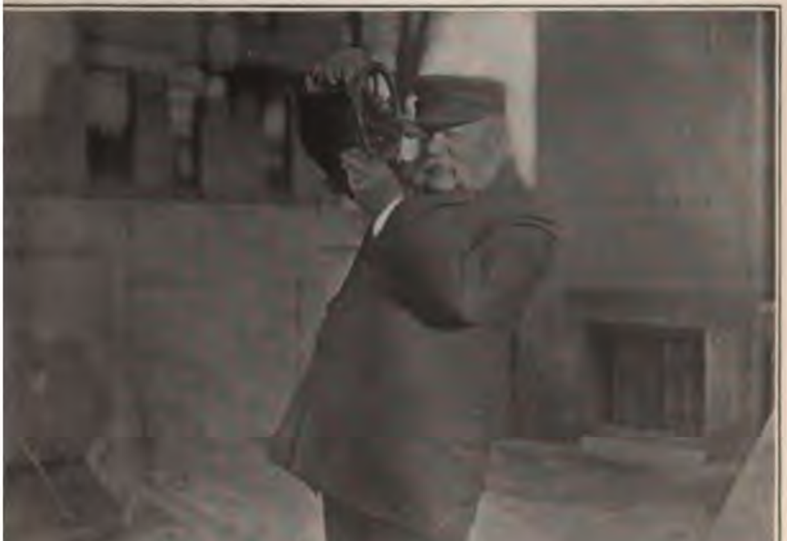


Fig. 1.

An endless screw attachment has been added to the later model, greatly increasing the facility with which the instrument is handled.



Sextant Held by Both Hands Taking Vertical Angles.

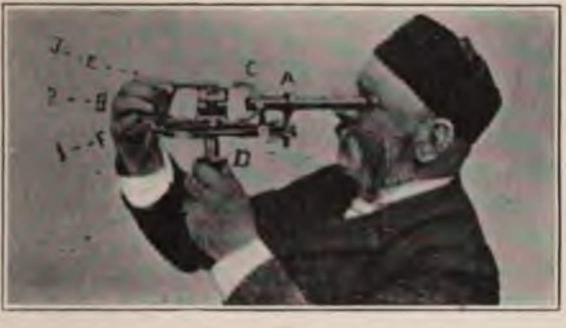
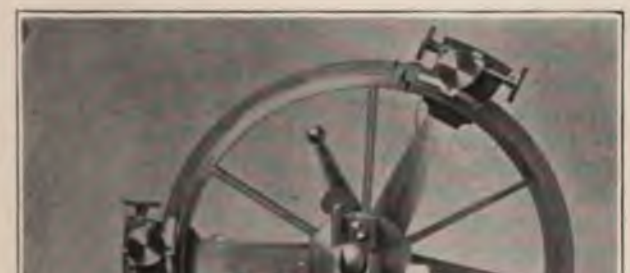


FIG. 2.



SET ONTO TRIPOD FOR VERTICAL ANGLES.

At the last meeting of the committee held in New Haven last Saturday afternoon it was decided, unanimously, there being one member present, to put it in, in the hope that it might assist members who had become weary in the search of a simple method of of tunneling, and this *is* simple indeed. The communication is as follows:

"We had a colored fellow to drive stakes for us during the past season and he, like many others, grew very rapidly in the profession, and evenings used to discuss engineering methods and *his way* of performing great feats. One evening one of his colored pals asked him how he would tunnel under a mountain, and he described how he would use his transit and level and turning points, etc., but one of his pals had a very unique method which you may not have heard of. He said, 'I would take two balls (not high balls) of twine and stand on the top of the mountain and let one roll down each side, and when they landed at the bottom, start my diggers.'"

Respectfully submitted,

GEO. W. F. GILLETTE, } Committee on
ROSCOE N. CLARK, } Field Work.

REPORT OF COMMITTEE ON SEWERAGE.

To the Honorable President of the Connecticut Civil Engineers and Surveyors Association:

The Committee on Sewerage respectfully submit the following report:

Since the Secretary is to tabulate all data in regard to prices, lengths, sizes, etc., the report of the committee will consist of a brief review of the situation in the state.

Great activity has been manifest in our state the past year in sewerage engineering, especially in the investigating and designing branch.

This has been brought about by the decisions of our courts, which all point in one direction, in favor of the riparian owners who have been damaged by the disposal of crude sewage into the water courses above their premises (or sacred rights).

The courts rule that even the claim of "Public Necessity" of our rapidly growing inland cities is not a sufficient reason why they should continue to pollute water courses even if it has been tolerated up to the present time. Riparian owners are entitled to the natural flow of the streams through their properties and their rights cannot be appropriated to the uses of municipalities desiring them unless proper restitution is made to the owners.

The city of New Britain has had so many decisions against it for the pollution of the small streams passing through it that it has become a very serious matter and already cost the city many thousand dollars in settlement of suits for damages. As a result of this the city has perfected plans for constructing about 50 miles of new sewers, part sanitary and part storm water, also for the construction of filter beds. The Court of Common Council has adopted the entire scheme which is estimated to cost about $500,000. The disposal system is the downward intermittent filtration system.

The city of New Britain will apply to the Legislature this winter for authority to issue bonds, and for other rights required in the execution of this work and probably proceed with their extensive plans early in 1901.

The city of Waterbury is in a very similar condition. In April, 1891, the Platt Brothers & Co., sued the city, restraining it from discharging sewage into the Naugatuck River. The plaintiffs owned premises on the river below Waterbury where they carried on a manufacturing 'establishment.

Waterbury has been discharging its sewage in a crude form into the river since July, 1884, and the plaintiff claimed that the water was so thoroughly contaminated that it gave off offensive odors rendering it unfit for use in manufacturing.

This case is the most famous sewage pollution suit in this state. Many witnesses were examined during the trial and experts called in on both sides. It was stubbornly contested by both parties and finally went up to the Supreme Court, where the decision of Judge Shumway of the Superior Court was sustained and by the final ruling of the courts, the city of Waterbury must cease discharging its sewage into the Naugatuck River after April 1, 1902.

Waterbury is so located that the municipal authorities find it a very difficult matter to know just what to do with their sewage. No land suitable for intermittent filtration is available near the city and it will probably be necessary to carry the sewage several miles below. This will be a very expensive project on account of the narrow, precipitous and rocky Naugatuck valley, through which it will have to pass. The final plans for this great work will probably be completed early in 1901 and the work commenced as early as possible.

The town of West Hartford has prepared plans for sewering their streets on the separate system. They originally expected to construct some kind of a small filtration plant, but upon further examination and upon the recommendation of Robert A. Cairns, secretary of the Connecticut State Sewerage Commission, they find it is feasible to enter the Hartford system of sewers by gravity through Elmwood and New Britain avenue, and have made formal application to the Board of Street Commissioners for their permission to unite their system with that of Hartford.

The application has been referred to Mr. C. H. Bunce, City Engineer of Hartford, for an examination and report on the scheme. This West Hartford district is topographically a part of the watershed drained by the intercepting sewer of Hartford, and if this sewer is large enough to provide for the additional area of West Hartford and the city of Hartford is willing, it would seem that this is much more desirable, especially when the maintenance of the system is considered than any form of disposal works.

South Manchester has provided a system of disposal the past year similar to that used by Meriden and Bristol.

When these projected works are finished and put in operation, of the eighteen cities in the state with water supply, seventeen will have been sewered.

Fourteen will still discharge their sewage uncleansed into water ways.

Of the boroughs, the most thickly settled next to the cities, eight of the twenty-two with water supply will have sewers; only two will cleanse their sewage.

Of the twenty-one remaining towns with water supply, nine will discharge their sewage uncleansed. The other eleven have no sewers and but a partial water supply. From which it will be seen that it is only a question of time, and of comparatively short time at that, when these cities and towns must awake and face the problem which confronts them.

(Signed) F. L. FORD, Chairman.
J. FRED'K JACKSON.

TY OR TOWN.	L	REMARKS.
	1	
	2	
	2	
wich	1	
	1	anholes.
		“
	1	wer removed and replaced by new 36 in. Brick.
	1	
		moved and replaced in same trench by 24 in., 18 in. and 15 in.
rd......		
	1	

SPRINGSIDE SEWAGE DISPOSAL PLANT.

Filter.	Depth of Sand.	Sand.		In operation since.	Average rate of Filtration Gallons per Acre Daily.	Average Per Cent. Removed.					
		Effective Size.	Uniformity Coefficient.			Solids.	Mineral	Organic	Free Am'onia	Albuminoid Ammonia.	Date when samples were taken.
1	Top Layer 18"	.33	2.14	Sept. 23, 1899	300,000	.76	.46	.91	*	.97	Feb. 15, 1900.
	Bot'm Layer 30"	.38	3.12		110,000	.64	.38	.88	.35	.96	June 20, 1900.
	†63"	†.48	†2.4		†67,000					†.86	

†Lawrence Station.

*Free Ammonia showed increase of 87 per cent.

REPORT OF COMMITTEE ON ELECTRIC RAILROADS.

To the President and Members of the Connecticut Civil Engineers and Surveyors Association:

Gentlemen:—Your Committee on Electric Railroads begs leave to submit the following report:

Written and verbal requests for interesting data have been made to many members of the Association with the usual reply that their work had been routine or repair work of no especial interest to the Association. As chairman of the committee I fear my personal report must be of the same tenor, as my only construction work during the past year has been about a mile of suburban work near the Yale Field, and between four and five miles in the city, in double tracking Whitney avenue.

For suburban work we are using sixty pound standard T, in sixty foot lengths, with six hole angle bars. In the city we use eight inch T with twelve hole joints, all special work for the same being of guarantee construction.

One of our items of greatest expense in track work has been due to the city's laying [illegible] permanent pavements in streets where our tracks were in need of no repairs; but on account of changes in grade for the new pavement we were obliged to retamp and line our tracks. We found in many instances the rails had become hooked down at the joints, and it was impossible to secure a good surface in the usual manner, as the centers would come up with the joints. We adopted the method of tamping up to the best surface [illegible] in the ordinary manner, and then laid the concrete bed [illegible] came about two inches above the ties. We [illegible] the joint ties and raised the rail with a [illegible] the proper thickness to bring the rail [illegible] the shimming as far back as was necessary to [illegible] the quarter ties from their bed. As [illegible] joint. In the above manner we have [illegible] smooth riding track where it would have been impossible were it not for the concrete holding down the centers when the joints were finally strained up to a true surface. In general I am a firm believer in the use of iron shims when repairing old track where the joints have become depressed, say up to three-quarters of an inch, instead of raising the ties off their bed and retamping, as I have found track to stay up much better under the above method, and the amount of pavement taken up is much less.

I cannot refrain from a word regarding the use of guard rails on curves, as I think certain roads have given the subject too little attention. I believe no fixed rule can be laid down as to the maximum radius to be guarded but that each separate curve should be considered with regard to the speed likely to be used at that point, the character of the bed as to keeping up the elevation, and lastly and most important, what would happen to the car in event of leaving the track. If the curve is so situated that a car leaving the track would have a sheer fall or be likely to overturn, then curves of quite large radius should be guarded, not only as a matter of insurance for the railroad company, but as a duty to the passengers.

The following data taken from the "1900" report of the railroad commissioners may be of interest to the members:

Total length of street railways operated June 30, 1900, 499,766 miles, an increase for the year of 57,262 miles. Total cost of construction as reported is $20,571,166.

Total number of passengers carried, 64,109,819, as compared with 53,352,417 carried by the steam roads.

The number of persons reported injured during the year was 217, of whom 39 were killed.

There have been 32 passengers killed, and 116 injured. Of this number 28 passengers were killed and 14 injured in the accident at Peck's Mills on the Shelton Street Railway. No employees have been killed, and only 5 injured. Seven other persons have been killed and 57 injured.

J. KEELER PUNDERFORD,
J. L. ADAMS,
T. C. B. SNELL,
Committee.

NEW HAVEN, CONN., Jan. 5, 1901.

Mr. J. K. Punderford, New Haven, Conn.:

Dear Sir:—You have asked me for some items that would be of interest to the "society" in connection with the construction of the Branford Electric Railroad this past year. In general the work has been routine, no particular difficult problems having to be overcome. I may say here that when the right-of-way is located and purchased the greatest problem is disposed of. The total length of the line is 5.2 miles, including sidings about 6 miles. Owing to the location, and the points with which we wished to connect, it was necessary to cross a number of salt meadows. About one-fifth of the entire track being floated on corduroy upon these meadows, the mud varying from 8 to 26 feet deep. The cost of trestling these meadows would have been about $40,000; to fill them was out of the question, no filling being available. Old ties were purchased of the New York, New Haven and Hartford Company and laid with broken joints, as you would a brick pavement. The cost laid on the meadows was about 13 cents per tie—8 cents f. o. b., and 5 cents for carting about 2½ miles, and laying. The ties averaged in width laid .92 of a foot. The cost of this construction (the fills on the corduroy averaging about 4 feet), was about $1.20 per running foot, or less than one-fifth the cost of trestling.

Yours very truly,

A. WILLIAM SPERRY.

NEW HAVEN, CONN., January 7, 1901.

Mr J. K. Punderford, Chairman Committee on Electric Railroads:

Dear Sir:—Your letter of December 15th, asking for report of any work done by me in electric railroad building during the last year, that might be interesting to the society, received. In reply I enclose a brief description of the third rail electric road running from Hudson to Albany in New York state. Although it is not in our state it is owned by Connecticut men. A. M. Young of Waterbury being President, the Chief Engineer F. M. Smith of East Haven, is a Connecticut man, and finally the Contractors, C. W. Blakeslee & Sons of New Haven, are also Connecticut men, and so it can be truly said to be a Connecticut enterprise.

Very truly yours,

CLARENCE BLAKESLEE.

THE ALBANY AND HUDSON RAILWAY AND POWER COMPANY.

The Albany and Hudson Railway and Power Company are op- ating an electric railroad by means of the third rail, and as this the longest third rail road in the country, a short description of road may be interesting. The road runs from the New York ntral Depot on the Hudson to the Post Office in Albany. Through streets of Hudson it is operated by the overhead trolley for a tance of about one and three-quarters miles, when the third rail gins on the Company's own right-of-way, and this continues for listance of thirty-eight miles to Rensselaer, when the overhead lley is again used for about two miles to the terminus in Albany. iat part of the road operated by the third rail is fenced by a 5 foot re fence of small mesh, and as the railroad crosses highways at ade, these grade crossings are carefully protected by standard ttle guards. Every precaution is taken to keep people and ani- als off the right-of-way, and so far, although the road has been nning two months and a half, no accident from contact with the il has occurred.

In the construction of the road the very best materials were used, d upon that part of it that is under consideration, namely, the irty-eight miles of third rail, 80 pound T rail with continuous rail int was laid with sixteen ties every 30 feet. The roadbed was aded to a depth of 1 foot below base of rail, and then ballasted ith a good gravel ballast. Eighteen or twenty miles of this road as through a clay country with no ballast at all adjacent to it, so at the question of ballast was quite an item of expense.

After the owners of the railroad had decided to use a third rail to erate the road with, a good deal of time was spent, and much oney expended in investigating as to what was the best location r the third rail, and what was the best and most economical sec- on. The rail used by the New York, New Haven and Hartford ailroad was not considered as the most practical for a road that as to be used in carrying both passengers and freight, one great jection to it being the great danger of accidents caused by the rake irons and other parts of a freight car that hang low coming contact with the rail. Finally the plan of putting the rail outside f the stock rails was adopted. The rail is of exactly the same sec-

[illegible] as the stock rails, 80 pound, [illegible] a lower carbon rail, making it softer and more [illegible]. In laying the track [illegible] was [illegible] were standard [illegible] rails [illegible]. A [illegible] pipe [illegible] and [illegible] was [illegible] which the rail sat. The rail was [illegible] the stock rails, and was [illegible] from the nearest rail. The third rail was [illegible] by means of [illegible] tangents. The rails [illegible] center to center. The [illegible] No. [illegible] after it was in place [illegible] with a power of 300 tons, and the [illegible] pressure of 150 tons power [illegible] the current being carried [illegible] rails [illegible] the overhead [illegible] is depressed [illegible] switch back [illegible] main track the side [illegible] could not be otherwise [illegible] and as soon as [illegible]

[illegible] could not be used in the [illegible] with overhead [illegible] small [illegible] rail [illegible] was [illegible] advantage, so that now [illegible] or more, are [illegible] is used on the [illegible] main line. The cars [illegible] small [illegible] side of the car [illegible] on the other side

[illegible] maximum grade [illegible] 300 feet [illegible] 1,000 [illegible] crosses by this means the Boston and Albany Railroad, and also the New York Central Railroad with clear head room over each of them of 25 feet, and is on a 3 per cent. grade. The power station is located at Stuyvesant Falls, about ten miles from Hudson and thirty miles from Albany. This location was chosen on account of the fine water power found there. The natural fall from dam to power house was above 100 feet, and this has been increased by the building of a fine cut-stone dam to 120 feet fall. The water is carried from the dam to the power house by means of twin steel pipes, each 7½ feet in diameter, and 3,600 feet long. The ditch made to receive these pipes was for a considerable distance through solid rock with a cut of from 40 to 50 feet high, and 20 feet wide at bottom. In the power station is also an auxiliary steam plant capable of developing 2,000 horse power, for at the present time the water power is not to be depended upon for but about eight months of the year, but a large storage reservoir is to be built in the spring, when it is expected to run by water power nearly if not quite the twelve months. In the power house an alternating current of 16,000 volts is generated and transmitted thence by bare copper wires to three transforming stations where it is transformed to low tension direct current to the third rail. In the power house is also generated direct current, and this is transmitted to the third rail at a short distance from the house.

The transforming stations are located as follows: One at Hudson about eight miles to the south of the power house; a second one at North Chatham; this is about twelve miles to the north, and the third at East Greenbush, twenty-four miles distant from the power house, and to the north of it. The third rail is tapped in at these four places, namely: Hudson, Stuyvesant Falls, North Chatham and East Greenbush, and so far no trouble has been found on account of lack of power, although the current is carried thirty-eight miles.

ELECTRIC ROAD WORK REPORTED FOR 1900.

Name of Road.	Length of New Work.	City or Suburban.	Rail Section and Weight.	Pavement.	Remarks.
Danbury and Bethel Street Railway Co.	15,000 feet	Suburban.			Preliminary Survey now under way.
Greenwich Tramway Company	2,000 "	"	T 70 lbs.	Brick.	
Meriden Electric Railroad	6,150 "	"	6 in. T 65 "		
Montville Street Railway Company.	57,036 "	"	T 60 "		
Stamford Street Railroad	2,452 "	"	T 70 "		

ORT OF COMMITTEE ON BRIDGES AND STEEL CONSTRUCTION.

committee has nothing of special interest to report, but
hered a few general statistics and desire to present the
r your consideration. Although your committee has had
o the sales book of several bridge and structural steel com-
it was not deemed advisable to do more than give a sum-
the amount of material, and approximate cost of same,
the State of Connecticut during the year 1900. This
s to 6,271 net tons, at a cost to the purchaser of $588,000,
approximately as follows :

ildings	3,598	tons
ilroad Bridges	2,471	"
ghway and Electric Railroad Bridges	202	"

last item is very small, representing merely the renewal of
den structures, with the exception of four (4) electric rail-
idges, one built on the extention to the Meriden, Southing-
Compounce Street Railway, and the others on the Putnam
nielson Railway. In all there were 37 structures erected,
nsequently none of them of magnitude.

ilroad bridges, the location of the largest number of spans,
tonnage, was at Bridgeport, Conn., caused by the separation
grade crossings at the west end of the city. This required
,448 tons of metal and marks merely the beginning of the
The bulk of the railroad work was, of course, executed
New York, New Haven and Hartford Railroad Company,
built 25 bridges weighing 2,286 tons, of which 519 tons were
renewals of old structures, and 1,767 tons to the elimination
de crossings. Twelve of the bridges were for four tracks,
r three tracks, one for two tracks, and the balance for single

[illegible]

[illegible] building [illegible] [illegible] Company [illegible] [illegible] tons of steel [illegible] 40 tons [illegible]

[illegible] a part of the immediate future.

Prices of material, after great fluctuations, have assumed a stability which will undoubtedly remain, and the prices of all forms of structural material will probably gradually approach a common price at about [illegible] per pound. The formation of new associations among the rolling mills, which is constantly going on, and the strengthening of old arrangements will assist in this. At present the output of nearly all standard shapes, bars and plates is thus controlled.

The latest form of interest in connection with structural steel manufacture is the formation of the American Bridge Company, whereby twenty-four separate plants are brought under one management. It remains to be seen what effect this consolidation will have on the selling prices of finished work.

Prices for finished work are at present nearer the cost of raw material than ever before known in this country. The immediate future at least shows that uniformity of prices will rule for all finished products of steel, and that no great change from the present prices is probable without similar changes in the cost of the raw material.

In highway work the use of wood for floors is rare at the present time. The same is practically true of railway work, with exception of floor systems of overhead road bridges. It would m as though the time had arrived for the use of solid floor dges for the more important city bridges for this purpose, where design is such that the steel work may be protected from the l gases by some sort of fireproofing. This construction is in in the west and, while possibly a sufficient time has not elapsed the exact determination of its success, it seems more than likely t the engineers are on the right track.

ARTHUR L. DAVIS,
W. H. MOORE,
H. C. COLLINS,
Committee.

BRIDGES AND STEEL CONSTRUCTION REPORTED FOR 1900.

Location.	Kind of Structure.	Contract Price Exclusive of Masonry.	Length, Width, Span, etc.	Purpose.	Remarks.
Central New England R. R.	Steel Viaduct, 10 spans	$11,466.00	344′ 6″	Replace Wooden Trestle.	New Hartford, Conn.
" " "	Deck Plate Girder, 4 spans	10,874.00	265′-0″	Replace Howe Truss.	Housatonic River-Canaan.
Hartford	Wooden Foot Bridge.	210.00	100′-0″	Foot Bridge.	2 spans, each 50 ft. day labor
Middletown.	Iron Bridge.		70′-6″	Highway.	Total cost $1,554.00.

REPORT OF COMMITTEE ON MASONRY.

Connecticut Civil Engineers and Surveyors Association :

past year must have been a very dull one for masons in ate, judging by the response, or rather lack of response, to cular sent out by the President of the Association, as no re- ave been received by this committee in answer to his in- .

ough not situated within the boundaries of Connecticut, the ations recently erected by the United States Government at Gardners, Gull and Fishers Islands, and at Napatree Point situated, geographically, and are of such vast importance in tection of our state from foreign invasion, that they may claimed as coming within our jurisdiction.

h the consent of Major Leach, engineer in charge of this dis- Mr. W. C. Briggs, formerly engineer and inspector on the at Gull and Plum Islands, has courteously furnished this ttee with some notes regarding the work at these two points, construction of which a very large amount of concrete of nt kinds was used.

magazines, bomb-proofs, etc., are all constructed of con- the heavy work being built of what is called "quarry grout." it is so called we do not know, unless it be for what an army would call "strategic reasons," to deceive the enemy, for t, in the form of grout, is not used, and the stones are not ed. It is made of large boulders, varying in size from a few feet to a cubic yard in volume, imbedded in concrete.

theory of the construction being, that in case a shot should the wall it would be deflected from a straight course by these , and so the penetration would not be so great as it would be mass was a homogeneous one. We hope that this theory will emain a theory, and not be subjected to a practical demon- on in a business way.

No attempt was made to place the large stones in regular courses, the only restriction being that a space of at least eight inches should be left between them to afford sufficient room to assure a proper ramming of the concrete. As much "grout" as possible was put in, and it amounted to about 65 per cent. of the mass.

In narrow walls and footings, concrete was used without the "grout." The concrete for this work was made of 1 Rosendale cement, 2 sand and 4 stone.

Two grades of Portland concrete were employed, viz: a 1, 2 and 4, and a 1, 3 and 6 mixture.

All concrete surfaces exposed to the weather have what is called a granolithic finish. The granolithic is a Portland concrete mixed in the proportion of 1, 1½ and 2, the sand being screened and much finer than that used for ordinary concrete. The gravel was also screened, the size varying between coarse sand, and what would pass a ¾″ mesh.

The granolithic finish was applied to the vertical surfaces as the walls were being built up, the method employed being as follows:

The bed to be covered with concrete was first cleaned and grouted with neat cement. A line of boards, each 1 inch thick and about 12 inches high by 30 inches long was then placed against the forms in a vertical position. Each board had nailed to it, at each end, a wedge shaped cleat a few inches higher than the boards, the extra length serving as handles. The cleated side of the board was placed towards the forms, and between the cleats and the forms other wedges were placed so as to make the space between the outside of the board and the form two inches.

The concrete was then dumped on the bed and rammed against the boards. When the ramming was completed the wedges were removed and the boards pulled out gradually as the space was filled with granolithic grout. The granolithic was worked with a tamping bar to remove air bubbles and to force the grout into intimate contact with the green concrete. With perfect forms and careful work an excellent and durable finish may be obtained.

As a rule, where granolithic was used, the backing was Rosendale concrete. Some of this work has been exposed to the action of frost for three winters with no ill effects.

Generally, the forms were removed as soon as practicable, and a very thin coat of mortar was applied to the walls, the plastering being rubbed with a cement bag so that the final effect was that of a coat of paint. This gave a uniform and fine appearing finish.

The method of finishing the horizontal surfaces was practically the same as that employed in laying cement concrete sidewalks. The concrete was brought up to within about twelve inches of the finished surface. It was then divided into squares of six or eight feet; then upon alternate squares Portland concrete was placed to within three inches of the finished grade; straight edges were then set on the lines of the squares, and to the finished grade. A rather wet granolithic was then placed on the concrete and screeded to a plane surface, and then floated with wooden floats until brought to a smooth finish. This surface was troweled with plastering trowels, and during the process a dry mixture of Portland cement and very fine sand was thrown upon it, which hastened the setting of the cement and effected a uniform and close grained surface.

The concrete was mixed in a Cockburn, Barrow & Machine Co. mixer, and cars were employed to deliver the materials to the mixer from the storehouses and to haul the concrete from the mixer to the work.

Mr. Briggs has furnished the following estimate of the cost of mixing and placing concrete, based upon an average day's work of 160 batches of concrete, or 128 cubic yards.

This does not include cost of materials, fuel, wear and tear of machinery, etc.

TRANSPORTING INGREDIENTS TO MIXING PLATFORM.		
6 Laborers @ $1.50	$ 9.00	
1 Foreman	2.00	
1 Engineer	2.50	
	$13.50=128 cubic yards @	$0.105
MIXING.		
12 Laborers @ $1.50	$18.00	
Engineer	2.50	
	$20.50=128 cubic yards @	$0.161
Carried forward		$0.266

Brought forward		$0.266
TRANSPORTING CONCRETE.		
12 Laborers @ $1.50	$18.00	
1 Engineer	2.50	
	$20.50=128 cubic yards @	$0.161
PLACING CONCRETE		
20 Laborers @ $1.50	$30.00	
2 Engineers @ $2.50	5.00	
1 Foreman @ $2.00	2.00	
	$37.00=128 cubic yards @	$0.289
	Total	$0.716

Granolithic is worth about $0.80 per square yard.

In some of the rooms of some of the fortifications, where the concrete was relied upon for preventing the dampness from striking through, the ceilings were very wet after a heavy rain, although the thickness of the concrete was fifteen or twenty feet.

At Plum Island the rooms were made perfectly dry by the following method. The concrete was brought to a plane, smooth surface or surfaces, about three feet above the level of the ceiling of the rooms. After the concrete is thoroughly dry a coat of hot asphalt is applied to it and at once covered while soft, with tar paper. Two courses of tar paper and three coats of hot asphalt, applied in this manner, suffice to make a thoroughly damp proof course. While the last coating of asphalt is hot, hot sand or fine gravel is thrown upon it. After the asphalt has become hard, the concrete construction is continued.

The rooms, magazines, etc., are surrounded by a four inch air space extending from the footing to the damp proof course, the latter draining into these air spaces, which in turn are connected with the sewer

Returning now to our own proper "bailiwick," the New Haven Water Co. has constructed a small masonry dam, or, perhaps more properly speaking, a retaining wall at Maltby Lake, No. 1.

This was constructed for the purpose of increasing the capacity of this reservoir by raising the lake five feet, and it was deemed unwise to do it by increasing the height of the old earth dam.

The wall is eight feet in width, under the coping, vertical on the

d with a batter of four inches to the foot on the face. The
m height is about 46 feet. The length on top is 171½ feet,
additional length of 22 feet in the overflow.

ody of the dam is built of stones quarried from a ledge
ree hundred feet from the dam, but as the character of the
as such as not to admit of their being readily shaped with
er, the face, above the surface of the ground, was built of
ven sandstone, as was also the coping. The wall was rub-
onry, laid in 1 to 2½ Portland cement mortar. The back
of the wall was plastered with mortar composed of one part
paste, two parts Portland cement, and four parts sand,
after it was dry, was painted two coats of cement grout.
e wall was completed, the earth dam was raised to the level
op of the wall, and protected from wave action by a layer
ap.

xcavation and sheeting of the trench for the dam, and all
g of the rock was done by the Water Company, and while
k was in progress one man was constantly employed by the
y to keep the surface of the masonry wet by sprinkling it
ter.

work, except the preparation of the foundations and the
ling and rip-rapping, was done under contract by Charles
keslee & Sons of New Haven.

prices for the work were as follows: Rubble masonry of
one, $4.95 per cubic yard; rubble facing of East Haven
ne, $6.75, and coping and other cut stone of East Haven
16.00.

Respectfully submitted,

Charles A. Ferry,
A. William Sperry,
Charles M. Crawford.

REPORT OF THE SPECIAL COMMITTEE ON HIGHWAY CONSTRUCTION.

To the Members of the Connecticut Civil Engineers and Surveyors Association:

Gentlemen:—The following interesting facts and suggestions are from the office of the Highway Commissioner of this state:

The amount appropriated by this state for the improvement of highways for the past two years was $350,000. In towns with a grand list of $1,000,000. or less, the state has paid three-fourths of the amount expended by such a town up to $4,500. In towns with a grand list exceeding $1,000,000, the state has paid two-thirds of such expenditure. During the last two years, 153 of the 168 towns of the state have applied for state aid in improving highways. All but nine of the 168 towns of the state have been granted some portion of the state appropriation, during the six years since the passage of the Good Roads Law. Of the 153 towns granted aid during the past two years, 39 have never before received state aid. In 52 towns the selectmen have taken the contracts in behalf of their towns. Upon the completion of the past two years' work there will have been constructed about 109 miles of good roads, in addition to the aggregate length of such roads previously built, which may be regarded as a splendid showing for this small state.

The statute of 1899 is generally regarded as a very good one, and is not likely to be much changed by the General Assembly of this year.

Great care has been taken by the Highway Commissioner to see that the money appropriated for highway improvements was wisely and carefully expended, and also to see that improvements were made where most needed and where the greatest benefits would result. The improvements made under the State Highway Law seem to have given good satisfaction to the people where the work has been done and to the public at large.

From one or two members of this committee have come some criticisms concerning the present methods of highway construction, offered, however, as the chairman believes, in no spirit of hostility or unfriendliness to the present system or to those who are directing the work.

One member sends the following suggestions :

1st. The specifications should be clear and more carefully enforced than is now the case. To accomplish the latter end an inspector should be on the work from its beginning to its completion.

2nd. For the most successful carrying out of state highway work in Connecticut, I believe the control should be in the hands of an able engineer corps from start to finish. This would produce a greater uniformity in results than is obtained under present conditions.

3rd. The Board of Commissioners and the above named engineer corps should be non-partisan so far as is possible, and the latter especially, should be chosen for their knowledge of the work and their ability for carrying it out.

With all due respect to the present Commissioner and his predecessors, and for the work they have accomplished under difficulties, there is still much to be desired in the way of legislation for highways in Connecticut.

Another member of the committee thinks too little depth of stone is used on the state highways. He evidently favors using a telford bottom course much more frequently than is now done, particularly where the roadbed is not of a dry and gravelly material, and where stones now cumber the ground at the roadsides, which might be thus used very advantageously.

The Highway Commissioner has very wisely allowed and encouraged the expending of a larger proportion of the appropriations than formerly for what may be very properly termed permanent improvements, such as reducing considerably the rate of grade and the total rise or fall between given points, providing for thorough under-drainage and surface drainage, etc.

Sufficient attention is not always given to the improvement of grades and lessening as much as practicable the total rise and fall between certain points. Road surfaces of broken stone, or gravel, or of any other material, however good and durable it may be, can be maintained only by frequent applications of additional material in small amounts as needed, or by periodical renewals of the surface; these state roads have given good satisfaction, when new and in first class condition, but if they are allowed to go too long without proper repair or renewal of the surface, or if the cost of maintenance is found to be unreasonably or surprisingly large, there is likelihood of disappointment and disapproval on the part of many people who have expected these roads would be very durable, and that it would cost but little to maintain them in good condition.

Besides the improvements made during the past year on highways under state appropriations, much similar work has been done by the various cities of the state. In some cases improvements in grades, etc., on highways have been made by town authorities without state aid.

The improvement of highways will go on, the mistakes of the past will be avoided in the future, better methods will be followed where improvement is found possible, and larger and better results will be obtained for the money expended.

Respectfully submitted in behalf of the Committee,

E. P. AUGUR, Chairman.

Highway Construction Reported for 1900.

City or Town.	Lineal Feet.	Width.	Kind and Depth.	Contract Price.	Cost if done by Day Labor.	Average Grading.	Remarks.
Bristol........	1,600	16 ft	Stone 6"	87c lineal ft.			"State Road" built by Town.
Danbury	13,200	20 "	Ordinary.				"State Road."
"	1,400	20 "	Gravel.				
Greenwich........	2,300	25 "	Grading.				This work was largely in rock and was done for $4,500.
"	675	20 "	Macadam 7"				
Hartford..	3,375	16 "	Tel'd Macadam 12"	$1.32 lineal ft.			"State Road."
Hartford Public Parks.	10,000	24 "	Macadam 12"		$1.50 lineal ft.	2 cu. yds. per lin ft	
Middletown...........	1,943	16 "	Macadam 6"				"State Road."
New Britain...	5,500	12 "	Macadam 8"	84c lineal ft.		½ " " "	" "
New Haven...........	1,618	16.5 "	Macadam 7"	54c sq. yard		None.	" "
"	2,192	32 "	Macadam 7"	44c "		None.	" "
New London.........	1,800	26 "	Macadam 5"	50c "		Light.	Private Road.
"	3,238	20 "	Macadam 7"	$1.39 lineal ft.			"State Road."
Norwalk	10,500	22 "	Gravel 6"	30c cu. yard.		6,000 cubic yards.	
"	6,800	24 "	Gravel 7"	50c lineal ft.		5,300 "	"State Road."
"	700	25 "	Macadam 7"	$1.55 " "		250 "	" "
"	1,400	21 "	Macadam 7"				Day "Work" prices not given
"	1,400	21 "	Gravel 7"				" " "
Pomfret......	2,900	27 "	Telford.				"State Road."
"	1,600	27 "	Telford.	$1.43 " "			
"	2,700	18 "	Macadam.				
Rockville	4,500	14 "	Macadam 7"	$1.00 " "		½ cubic yds. per ft	"State Road."
"	6,600	14 "	Gravel 8"	30c " "		1½ " " "	" "
Wallingford.	4,200	14 "	Macadam 7"	$1.07½ " "		6,000 cubic yards.	" "

REPORT OF COMMITTEE ON WATER SUPPLY.

To the President of the Connecticut Civil Engineers and Surveyors Association:

The water committee would respectfully report that they have received the following replies in reference to the work done in the state during the year 1900.

The report of Mr. Peck, in reference to the meters introduced in the city of Hartford, has not as yet reached your committee, although in a general way we were informally informed that the result thus far had been quite gratifying. Possibly other reports may in like manner become omitted.

Respectfully submitted,
GEO. H. BISHOP, Chairman.

BRIDGEPORT.

The construction of a new dam for the Bridgeport Hydraulic Company has been commenced on Beaver Dam Brook, in the town of Stratford, about seven miles from Bridgeport and four miles from the center of Stratford.

The dam is of earth, with a masonry core wall 1,000 feet long and 50 feet high from the bed of the stream. The inner slope is 2½ to 1 and the outer slope 1½ to 1.

Gate chamber, 10 feet by 8 feet. Intake pipe, 30 inches. Outlet pipe, 30 inches. Area of reservoir, 60 acres. Capacity, 500,000,000 gallons. Work was commenced in September and stopped about the 15th of December, when the work was about one-third completed.

SHELTON.

The construction of a masonry dam for the Shelton Water Company was commenced in September. It is to be 300 feet long and 40 feet high.

MIDDLETOWN.

The Middletown Water Board have laid 7,000 feet of 8, 6 and 4-inch pipe at an expense of $7,000, including yearly services, hydrants, gates, etc.

The State of Connecticut has constructed a storage reservoir, in addition to three heretofore built for supplying the Hospital for the Insane, the last having a capacity of 40,000,000 gallons. The dam was constructed in a natural ravine, with a concrete core wall over 40 feet in height, having a batter on each side of 1 foot in 10. Earth embankment with slope 2½ to 1 on the inside and 2 to 1 on the outside, width at top 16 feet, bed rock foundation for core wall. Portland cement, hand made concrete, the whole wall faced with cement mortar.

All substances removed from the entire surface flowed and placed on the outside of the embankment slope; inside slope rip-rap 2 feet thick.

The work was done in part by hired labor, such as the concrete walls, foundation, etc., the earth work by hospital patients, making the total expense to the state $16,500.

MERIDEN.

MERIDEN, CONN., Dec. 6, 1900.

Mr. Geo. H. Bishop, Chairman Water Committee, Connecticut Civil Engineers and Surveyors Association:

Dear Sir:— I have been requested by the President of our Association to give you information regarding any work done in the way of enlarging, adding to or improving our water supply, and give you in this communication a resume of what little has been done here in that line. We have made no enlargement or addition to our supply. Have repaired the south dam at Merimere, through which, it was found by investigation, water was percolating amounting to from 300 to 500 thousand gallons daily, depending on the height of water in Merimere. This repair consisted in excavating back of the concrete core and plastering the inside with two coats of Portland cement mortar, and afterwards backfilling the trench so excavated with clay puddle and cement grout. Our rainfall here for the fiscal year ending November 30, 1900, has been $38\frac{44}{100}$ inches, against $33\frac{51}{100}$ inches for the same period for 1899, the last two months, October and November, being for 1899, $3\frac{11}{100}$ inches, while for 1900 it was $7\frac{51}{100}$ inches, being almost double. We have in Merimere today a depth of 7 feet 4 inches, as against a depth of 0 feet 7 inches on December 1, 1899, having also a corresponding increase in our other reservoirs. This puts us out of all danger of being called upon to use our auxiliary pump located at Twiss Pond.

Very truly yours, W. S. CLARK.

NEW HAVEN.

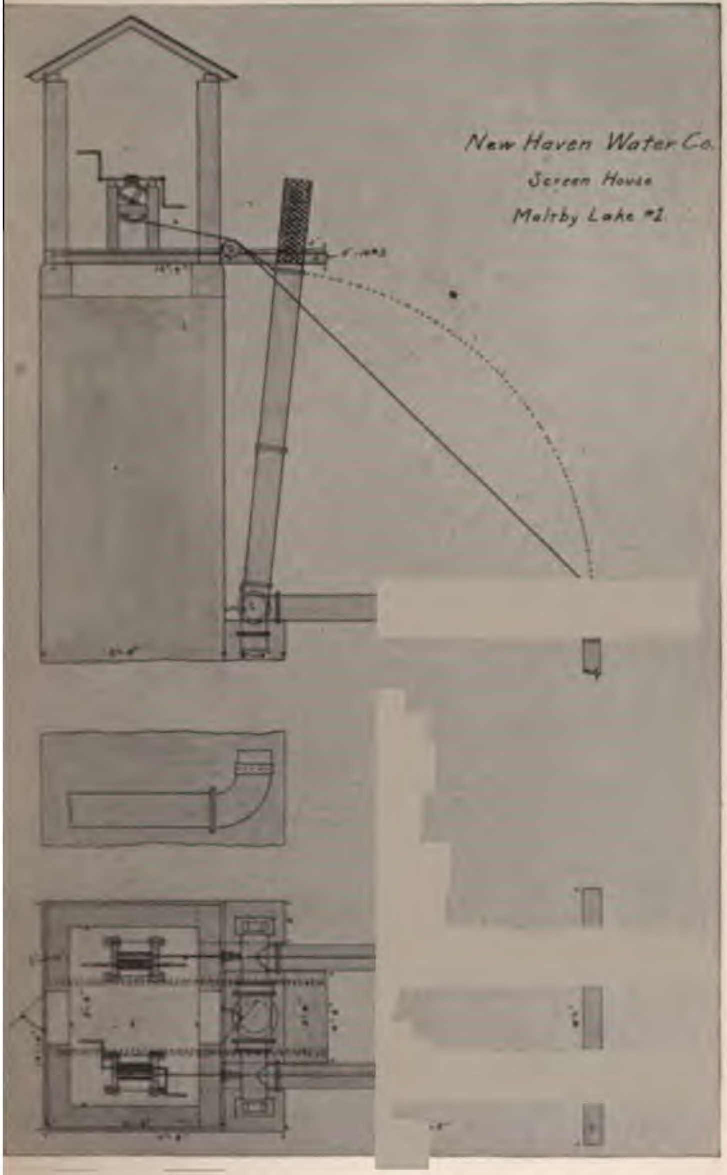
NEW HAVEN, CONN., Jan. 1, 1901.

Mr. Geo. H. Bishop, Chairman Committee on Water Supply, Connecticut Civil Engineers' Association:

Dear Sir :—As a member of your committee I herewith send you a little local information regarding the subject of "Water Supply," to be used in your annual report, in case you find it of any value.

The Branford Lighting and Water Company extended their mains last year to Indian Neck, laying about 3,000 feet of 8-inch pipe, 1,200 feet of 6-inch and 800 feet of small sizes.

The chief work of general interest carried out by the New Haven Water Company during the year just ended has been the improvement of its recently acquired water supply system for West Haven, Conn. The reservoirs used by the old West Haven Water Company have been superceded by a new one, which will give an ample gravity supply of fine quality at all seasons of the year. This reservoir, known as Lake Maltby No. 1, was formerly part of the New Haven system, and has been raised five feet in elevation by constructing a new masonry dam at the down-stream face of the old earth dam. It was not considered advisable to raise the old dam to the new height, as it was of uncertain construction and materials and depended for water tightness chiefly on a thin layer of cement concrete on the up-stream face. The new dam is about 40 feet high, is founded entirely on rock, and is composed of rubble masonry laid in 1:2½ Portland cement mortar. The down-stream face is of East Haven sandstone, and the body of stone from a


New Haven Water Co.
Screen House
Maltby Lake #1

The only new work or construction at the reservoirs being a 24-inch vitrified pipe conduit 16.700 feet long, costing about $40.000. 1.612 meters have been set during the past year.

There has been no shortage of water in the Hartford system for the past year.

Yours very truly,

W. E. JOHNSON.

NEW LONDON.

NEW LONDON, CONN., Dec. 31, 1900.

Mr. George H. Bishop, Chairman of Water Committee, Conn. Civil Engineers and Surveyors Association :

Dear Sir:—There is no work of construction of reservoirs or pumping plants in this part of the state to report.

At New London studies have been made for a supply for a second high service district, but no plan has been adopted. The quantity of water required will be small for several years to come, probably, so the pumping must be done by some means that will call for but little attention.

For the year ending September 1st the extensions of distribution mains have been 8,918 feet, at a cost of $7.484, all of which but 387 feet was 6 inches in diameter. 206 feet is of 8-inch and 181 feet is 10-inch ; 3,327 feet have been relaid at a cost of $3,168, 834 feet is of 8-inch cast iron to replace 6-inch cement lined, and 2,493 feet is 6-inch cast iron, nearly all replacing 4-inch cement lined.

A water supply for Groton has been under consideration both by a corporation and by a committee in the interest of public ownership.

The company which supplies Mystic and Stonington advertised in the newspapers for several weeks that the supply being low, it would be shut off from the consumers except for one hour per day. The Electric Light company has given notice that they will ask for the right to furnish those places with water.

Lake Konomoc, the storage reservoir for New London, is 13½ feet deep and contains 690,000,000 gallons when full.

On January 11th, 1900, the water stood 7 feet 5 inches deep and the amount in storage was about 289,000,000 gallons. O t, 1900, the water stood 12 feet deep with a storage of 560,- gallons. On December 1st, 1900, it was 5 feet 6 inches th a storage of 190,000,000 gallons.

then there has been a slight gain, but the year ends with a of about 90,000,000 gallons.

laily consumption has been 1,585,000 gallons, an increase of an 9 per cent. over last year.

Yours truly,

GEO. E. MANNING.

REPORT OF SPECIAL COMMITTEE ON FILING MAPS.

FARMINGTON, CONN., January 8th, 1901.

To the Connecticut Civil Engineers and Surveyors Association:

The special committee appointed at the last annual meeting to "frame some amendment to Section 81 of the General Statutes, relating to the filing of maps," met within a week after appointment, and have been at work ever since, compiling statistics and formulating an act to be presented to the General Assembly. I believe that we can, in a small way, make the engineers' records as effective as those of deeds.

The proposed act, which we herewith present, will require engineers to prepare maps with reference to the points of the compass. It also provides for the proper preservation of maps. We are acting in connection with the "Committee of the Legislature to ascertain how maps are kept and preserved."

AN ACT

CONCERNING HIGHWAYS AND MAPS OF LAND.

Be it Enacted by the Senate and House of Representatives in General Assembly Convened:

SECTION 1. When the owner or owners of any land shall have caused it to be surveyed, plotted and laid out into lots and projected streets or highways, and a map of said survey and plot to be made, and shall have caused to be endorsed on said map or appended thereto a certificate, duly dated, signed by such owner or owners and the surveyor having in charge such surveying and plotting, that said map is substantially correct, such map, when made to conform to the provisions and requirements of this Act, shall be received by the Town Clerk of the town in which said land is located

aced on file in his office ; said map shall thereafter be deemed
of the Land Records of said town and a part of each deed
ng thereto, and a copy of such map, duly certified by the
Clerk of the town in which said land is located, may be pro-
and exhibited in court, to the same effect and extent and for
ne purposes as copies of deeds now are or may be produced
hibited ; the Clerk of every town shall upon request cause
ertified a copy of any map on file in his office, and shall be
l to charge and receive for each such certification the sum
cents.

2. No street or highway shall be laid out or opened to the
by any person or corporation, until a map of such layout
n accordance with the provisions and requirements of this
d showing the width of each such street or highway, *to be*
than forty feet, and a profile of the same showing the grade
projected streets or highways, shall have been submitted to
ectmen of the town in which such highway is located, or in
nt that such projected streets or any of them are within the
f a city or borough, to the proper officers of such borough,
ere shall have been duly endorsed thereon or appended
the written approval of such officer, or of a majority of such
nen or Burgesses, nor until such map shall have been duly
the office of the Town Clerk of the town wherein said land
ed, and shall have been made to comply in all other respects
e provisions and requirements of this Act.

3. The owner or owners of any land who shall, in opening
dividing the same for the purpose of the sale of the same
portion thereof as separate parcels or building lots, lay out
ject portions thereof for streets or highways, shall before
ing a deed of any parcel thereof abutting on such projected
r highway, cause to be made and filed in the office of the
f the town wherein such land is located a map or maps of
et of land comprising said lots and projected streets or
ys, in all respects in accordance with the provisions and
ments of this Act.

4. Every Town Clerk shall receive each map which shall
red him for the purposes provided herein, and duly number

the same, and shall keep each such map in his custody in the same manner and for the same purposes as the Land Records are now and shall be by him kept, and shall also keep in a book duly prepared for said purpose a record of each such map, and of the number thereof, and of the date of filing of the same, and of the names of each of the owners of said land.

SEC. 5. No Town Clerk shall be required to receive any such map for filing in accordance with the purposes, provisions and requirements of this Act unless and until the proper filing fees therefor shall be duly tendered him at the time that such map is offered for such filing, and unless all of the other provisions and requirements of this Act shall have been duly complied with.

SEC. 6. Each such map shall show the points of the compass, the length and direction of each boundary line of each subdivision (expressed in figures), and the location of said lines with reference to two or more stone bounds, or other permanent monuments, and shall be made on a good quality of white drawing paper, or upon white drawing paper mounted on muslin, at the discretion of the Town Clerk, and shall not be more than thirty-seven (37) inches long by twenty-five (25) inches wide.

SEC. 7. The Selectmen of every town shall immediately cause to be prepared cases containing cards thirty-seven (37) inches long by twenty-five (25) inches wide, upon which the maps shall be pasted as they shall be filed, or books of the same dimensions into which said maps shall be so bound, in such a manner that they cannot be readily detached. If books are used, the Town Clerk shall require each such map to be mounted on muslin.

SEC. 8. Every Town Clerk shall be entitled to receive and collect the sum of One Dollar at the time that each such map is offered for filing with him, for the filing and indexing thereof in accordance with the provisions hereof.

SEC. 9. Every person who shall violate any of the provisions of Sections 2 [illegible] 7, shall be fined not less than Ten Dollars nor more than Twenty-five Dollars, each deed delivered by owner of land in [illegible] Section [illegible] shall be deemed a separate [illegible] any person, or officer of [illegible] shall sell or offer for sale any lot so plotted and laid out, abutting upon a projected street, in violation of the provisions of this Act, shall be fined not less than Ten Dollars nor more than Twenty-five Dollars, and the sale and offering for sale of each and every lot shall be considered a separate offense.

SEC. 10. If any such Warden and Burgesses, or Selectmen, shall refuse or neglect for a period of thirty days to approve and properly endorse any such map so presented for such purpose and being in accordance with the provisions and requirements of this Act, such owner or owners may appeal to a Judge of the Superior Court within twenty days after such refusal, or in the event of such neglect within twenty days after the expiration of said period of thirty days, and said Judge, after due notice to all parties concerned, and hearing, may order such Warden and Burgesses, or Selectmen, as the case may be, to approve and properly endorse said map or maps, in accordance with and for the purposes mentioned in this Act, or make such other order as such Judge may deem proper in the premises.

SEC. 11. Section 81 of the General Statutes, and Chapter CCV of the Public Acts of 1899, approved June 20, 1899, are hereby repealed.

EAST HARTFORD SEWER SYSTEM.

BY C. HENRY OLMSTED, EAST HARTFORD, CONN.

The central portion of the town of East Hartford, known as the East Hartford Fire District, having grown in population to the point where the necessity of better sanitary condition was apparent to all, decided to build a system of sewers. At first, public opinion seemed to be decidedly in favor of the "combined system." Probably on account of the extreme flatness of the country and large amount of ground water. After a careful consideration of the recommendations and reports of the engineers, the district decided to build what is known as "The Separate System" of the sanitary sewers.

Plans and estimates were made and adopted and bids advertised for. The system of bidding, or form of proposal, was as follows:

FORM OF PROPOSAL.

ITEMS.	Prices in Figures.
Price per lineal foot for furnishing and laying 30 inch pipe including gasket and cement joints.	$2.09
Price for each branch on a 30 inch pipe with detachable cover.	5.51
Price per lineal foot for furnishing and laying 24 inch pipe including gasket and cement joints.	1.44
Price for each branch on a 24 inch pipe with detachable cover	4.13
Price per lineal foot for furnishing and laying 20 inch pipe including gasket and cement joints.	1.07
Price for each branch on a 20 inch pipe with detachable cover.	2.10
Price per lineal foot for furnishing and laying 18 inch pipe including gasket and cement joints	.77
Price for each branch on an 18 inch pipe with detachable cover.	1.65
Price per lineal foot for furnishing and laying 15 inch pipe including gasket and cement joints.	.62
Price for each branch on a 15 inch pipe with detachable cover	1.20
Price per lineal foot for furnishing and laying 12 inch pipe including gasket and cement joints	.46

ITEMS.	Prices in Figures.
branch on a 12 inch pipe with detachable cover......	.82
l foot for furnishing and laying 10 inch pipe includement joints.	.39
branch on a 10 inch pipe with detachable cover......	.62
l foot for furnishing and laying 8 inch pipe including nt joints.	.33
branch on an 8 inch pipe with detachable cover.....	.41
l foot for furnishing and laying 6 inch pipe including nt joints.	.30
branch on a 6 inch pipe with detachable cover. ..	.23
l foot for all excavation and back-filling under 6 feet	.24
l foot for all excavation and back-filling 6 feet or over, ...	.30
l foot for all excavation and back-filling 8 feet or over, t....	.35
al foot for all excavation and back-filling 10 feet or 12 feet.	.45
al foot for all excavation and back-filling 12 feet or 14 feet ..	.55
al foot for all excavation and back-filling 14 feet or 16 feet ..	.80
al foot for all excavation and back-filling 16 feet or 18 feet ...	1.20
plete, each, [district to furnish castings]...........	27.50
omplete, each.....	75.00
nry bulkhead at mouth of sewer as per plans	408.00
price per cubic yard................	.25
eet of lumber ordered left in trench by engineer.....	20.00

t was let to the lowest bidder; work was started 0, and completed January 3rd, 1901, or in a little nonths. The system as completed, comprises about anitary sewers of salt-glazed terra-cotta pipe, including lateral sewers ranging from twenty-four inches to n diameter, with an outlet about six thousand feet ch terra-cotta pipe; eighty-five manholes and eight the Miller 6-inch siphon pattern. The siphons have r of four and a half feet, with a discharging depth and with a discharging capacity of 41 cubic feet. e built at all street intersections, or about 500 feet he distance was great between intersecting streets.

The comparatively small number of flush tanks is accounted for by the fact that there are a number of short 8-inch laterals to be constructed in the near future that will be equipped with flush tanks.

The depth of excavation ranged from 5 feet to 18 feet, and was entirely in sand or clay, no rock being encountered throughout the work. Quicksand was [illegible] but was not as hard to handle as most [illegible] Tight-sheathing, the use of [illegible] combined with [illegible]

[illegible]

pounds per foot. Joints were made much the same as with small pipe, except that the joints from the inside of the pipe were filled with neat cement. All manholes are either four feet circular or 3′x5′ elliptical, have eight inch walls, and are plastered outside from top to bottom with cement, and painted inside with a cement wash. Wherever possible, channel pipe was used for inverts. The grades on both main and lateral sewers are light. The maximum grade is only 1.6 per cent., and minimum grade .24 per cent. Most of the system is built on a grade of from .3 to .4 per cent.

American Portland cement in a mixture of one part by measure of cement to two parts of sand was used on all brick and stone masonry, and in the laying of all sizes of pipe, except the 30-inch.

The contract price will amount to about $59,500; extra work, or work not provided for in the contract, amounts to about $500.

This system as outlined, empties into the Hockanum river, a little less than a quarter of a mile from the point where the Hockanum meets the Connecticut river.

Realizing that the time was not far distant when this state, and I trust all states, would take some legislative action prohibiting the pollution of our streams and rivers by emptying into them the garbage and sewage from our cities and towns, this sewage system was so planned that we could for the present help to increase the nuisance that already exists by the pollution of our streams. But when the time came, as it must come, when all cities and towns shall be placed on the same footing in regard to this matter of pollution of streams, then we would probably be in a financial condition to erect a pumping plant and construct filter beds. The natural advantages of such a plant within 500 feet of where the sewer now enters the river, are very great.

No especially difficult engineering problems were met in the carrying on of the work. The sore point, or the work on which most stress was laid and the inspectors instructed to be most particular about, was tight joints—a very necessary characteristic of the separate system of sewers.

THE NEW BRITAIN SUBWAY.

F. H. OLDERSHAW, NEW BRITAIN, CONN.

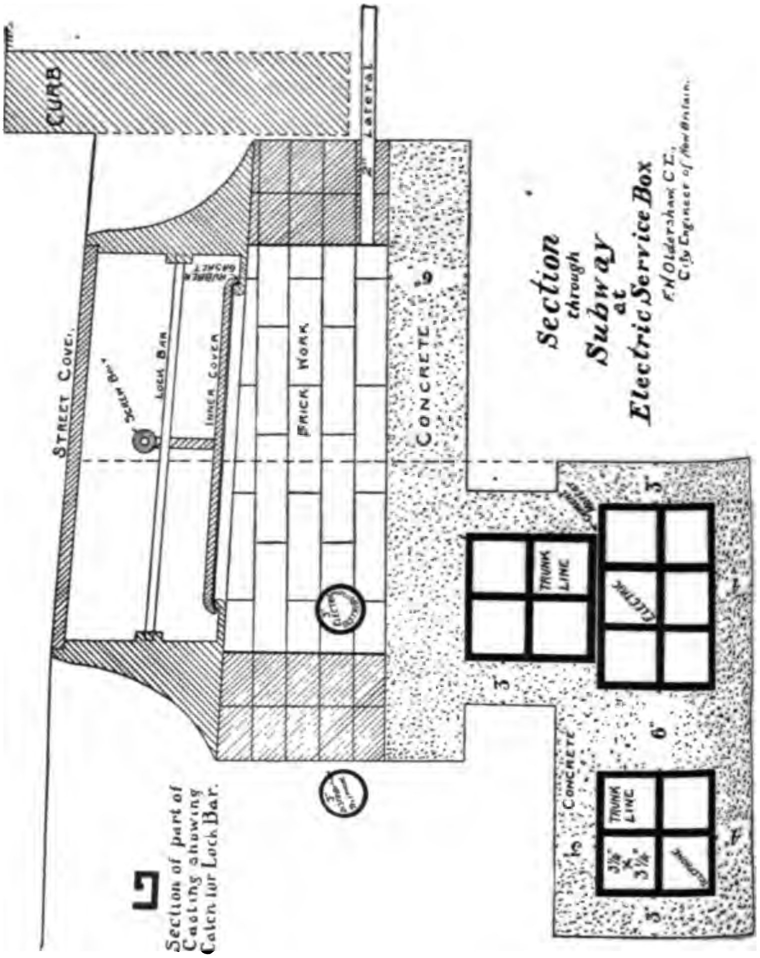
The city of New Britain has, and always will be, a progressive city, and its citizens are continually on the lookout for improvements in its municipal affairs. The last step taken in improvements, one that will certainly beautify the city, as it will remove a large number of unsightly poles and wires from the main thoroughfares of our city, is the laying of a subway or underground conduits for all electrical wires. The city can well be proud of its position as the pioneer city of this state in the movement of building and maintaining its own conduits.

During the session of the last Legislature, an act was passed by the Senate and House of Representatives convened in General Assembly, authorizing the city of New Britain to build, construct and maintain, in any street or highway, or in any part of any street in said city, main or lateral conduits, with manholes, and all other appurtenances pertaining to conduits, for telephone, telegraph, fire-alarm, electric lights, and all other electric wires now or hereafter used in said city, and to cause all such wires to be placed in said conduits, and to charge for the use of said conduits an annual rental.

In September, 1899, the Common Council of the city instituted a subway commission to look into the matter of conduits for underground electrical wires, and in April, 1900, the commission made a report of their researches into the matter to a city meeting with the result that a vote was passed authorizing them to issue bonds for the work, and to have plans and specifications made at once for the operation and completion of the work. Mr. E. R. Quimby of New York city made the plans and specifications for the work, and upon their acceptance by the Common Council, the work was begun in October, 1900, and completed in December, the city engineer having the charge of inspection and laying out of the work.

[illegible] thorough [illegible] the [illegible] underground [illegible] the American [illegible] All [illegible] The [illegible] water [illegible] of gases [illegible] the water [illegible]

[illegible]


CURB
Lateral
Street Cover
Screw Bar
Lock Bar
Rubber Gasket
Inner Cover
Brick Work
Concrete
Trunk Line
Trunk Line
3½ × 3½
3"
6"
Section through Subway at Electric Service Box
F. H. Oldershaw C.E., City Engineer of New Britain.
Section of part of Casting showing Catch for Lock Bar.

CONSTRUCTION.

In our construction, the conduits were laid on a four-inch bed of concrete, consisting of one (1) part Portland cement, three (3) parts sand and five (5) parts one-inch stone. The conduits were laid to such a depth that they would have thirty (30) inches of covering on top. In laying the conduits an iron dowel-pin was used in setting abutting ends of sections and all joints were close matched, is dowel-pin used was three or four inches long, with such a umeter as would fit the dowel holes in ends of conduit snugly. ro pins were required for each section of pipe. Every joint was otected with a single layer of coarse burlap, soaked in asphaltum d pitch compound, fitting tight about the joint. The burlap con- sted of a strip eight (8) inches wide, and overlapped twelve (12) ches. The burlap joint was protected by a layer of Portland ment mortar. A mandrel six (6) feet long, the end being three (3) ches square, was used for the purpose of centering the ducts and eeping them in perfect alignment. Where one conduit was laid n another, they were separated throughout their whole length by bed of cement mortar. The method of laying the conduit was s follows: When possible, the work was started from a manhole, lthough if desired or necessary, it can be started at any point of heline. A trowelful of mortar was placed on the concrete wherever he joint was to be made. When the length of conduit rested rmly on its bed, two dowel pins were inserted. A strip of creo- oted burlap was then placed so that it lay equally divided under he end of conduit laid and that of the next to be laid. The next ength was then put in line and dowel pins adjusted, and the two engths pushed tight together; the mandrel was then passed through he ducts for perfect alignment and to insure clear openings. If verything was found correct, the burlap was drawn tight and apped, and then plastered with a coat of mortar. In places where bend or curve in the line was necessary, short pieces were used nd cut at an angle. This was necessary in our work, as the sub- ay was laid about two (2) feet from the curb, and it was necessary t some points to run around the catch basins.

Manholes five (5) feet by five (5) feet by seven (7) feet deep were laced at all street intersections, and if the length between streets as over seven hundred (700) feet, one was placed between. The stance between manholes on our system ranges from two hundred 00) to four hundred and fifty (450) feet. The foundation for the nholes consisted of six (6) inches concrete. The walls of the nhole were eight (8) inches thick and built of the best quality d burned sewer brick. The walls were carried up to such a ght that the casting for the top came in conformity with the street grade. The casting consisted of a frame, street cover, inner cover of cast iron, a lock bar of wrought iron, and a screw bolt of gun metal. The inner cover was fitted with a hollow rubber gasket to secure a water-tight joint. The lock bar of wrought iron caught in two slots, one on each side of the casting, and the screw bolt went through the center of the lock bar and onto the top of the inner cover, so that after the rubber gasket was fitted by screwing on the bolt, the cover could be made perfectly water-tight. The whole top weighed about seventeen hundred (1,700) pounds. The conduit was so laid as to come flush with the inside face of the manhole walls. After the trunk line or conduits were laid from manhole to manhole, and covered on top and sides with three (3) inches of concrete well tamped, one-inch creosoted boards equal in width to that of the conduit, were laid on top of the concrete, after which loose earth was then thrown in, (the concrete having set in the meantime), and tamped well, so as to fill the trench to within eighteen (18) inches of the top. Two distributing ducts were then laid about ten (10) inches apart, each duct connecting with its respective manhole and having a separate system of service boxes or handholes. Thus each system, electric and telephone, are distinctly separate, having its own trunk line or conduit, manholes, distributing ducts and junction boxes. Ducts passing manholes and service boxes and not entering them, do not show on the inside at all. This distributing duct consisted of three (3) inch lap-welded wrought iron pipes, pains being taken to have the inside free from all scales or roughness which would injure the electrical cables. All joints were threaded and provided with screw couplings. This distributing duct was coated with a preparation consisting of ten (10) parts, by weight, of refined Trinidad asphalt, and thirty (30) parts, by weight, of coal tar pitch, to which was added sufficient dead oil to make a smooth, tough and tenacious coating.

The service boxes are laid at the discretion of the engineer, usually one for each building or lot. Their location and distance apart depends wholly on the number of blocks, stores, houses, etc., to be supplied with the different services or accommodations. One service box connects buildings or properties on the street that are opposite to each other, or nearly so. The service box on a subway may well be compared to a sewer hub on our sewers, except that more than one building can be connected with a service box, while only one connection with the sewer is accommodated by a single hub. These service boxes were thirty (30) inches in the clear, and like the manholes, had eight-inch walls of at least six (6) courses of brick work, hard burned sewer brick being used. The foundation for these boxes was also six (6) inches concrete. The top casting for these boxes was identically the same as those for the manholes, and had the same fittings, the frame weighing about ten hundred and fifty (1,050) pounds. From these service boxes, laterals were run to points six (6) inches inside of the curb and to such points as was directed by the engineer; most of the laterals were two (2) inch, but those at the terminals of the subway were three (3) inch. The pipes for these laterals were of same quality as that for the distributing duct and underwent the same preparaion. When laying these laterals, a No. 9 B. and S. galvanized iron drawing-in wire is put in each one and the ends fitted with a wooden plug. The company using these laterals completes the connection from the ends laid by the city to such buildings or places as they wish to supply with their service. Thus we have the service complete. The cables run through the trunk duct or conduits to the manholes. At the manholes service is taken from these electric cables through the distributor to the service boxes and thence through the laterals to the building or place to be supplied with the service.

RODDING.

After the construction work was completed, each duct of the trunk system was rodded from manhole to manhole, and each distributing duct rodded from manhole to service box, and from service box to service box, and a No. 9 B. and S. drawing-in wire left in each one. These rods are made of oak and are four (4) feet in length with a brass screw cap on the ends. One man gets into one manhole and starts the rodding with a length of rod, and by screwing on additional lengths, pushes the rod through to the next manhole. When the second manhole is reached, he inserts the end of the drawing-in wire into a small hole in the cap of the last rod and a second man in the second manhole pulls the rod through with the wire attached until the wire enters the manhole. Thus the rodding is continued until each duct of the trunk system, and all distributors are wired. In our system this work was accomplished with great ease and success, no obstruction of any kind being met in the rodding process in the whole system. According to an old adage, "The eating is proof of the pudding," and so I say the rodding is proof of the subway.

RENTALS.

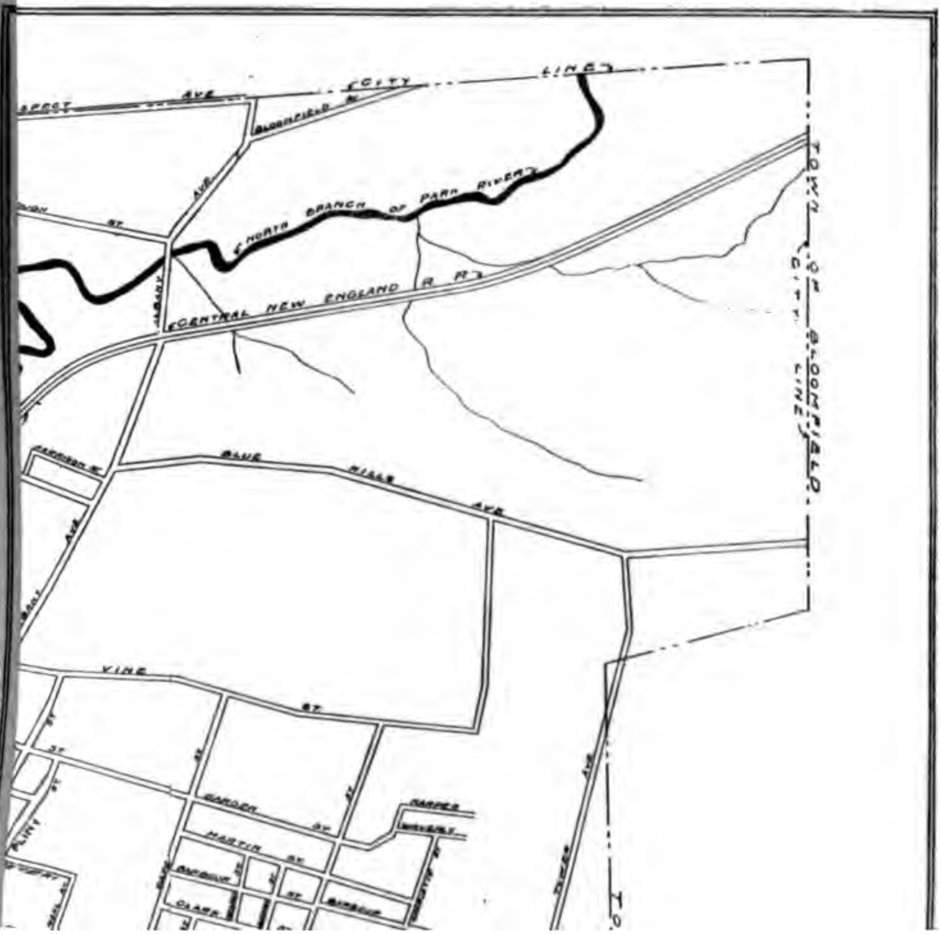
Owing to the incompleteness of our figures and to the fact that no report upon the matter has yet been made, I cannot treat the subject of rentals as I would like to. According to our charter the sum to be charged for the rentals of the conduits must be determined upon the following basis, viz.: A reasonable interest upon the cost of construction, and the creation and maintenance of a sinking fund for the repair, maintenance and cost of conduits, manholes, etc. Suppose that one system completed (not including laterals), cost for construction, engineering and superintendence, a certain sum which we will call "y." The sinking fund for repairs, maintenance and cost of conduits, etc. (this fund, of course, includes subway commissioner's salaries,) estimates at a sum we will call "x." The interest on our bonds (which are twenty year bonds), amounts to a sum we will call "z." For a twenty year basis, this would make our cost of subway $\frac{x+y+z}{20}$. Now if the number of duct feet laid was represented by "a," our rental would be $\frac{x+y+z}{20a}$ per duct foot. Baltimore has a system very much like ours, and this rental figures 7½ cents per duct foot. In the same way, we figure the cost of laying and maintenance of our system of laterals, and by dividing by the number of feet of laterals laid, estimate our rental for laterals used. Thus having the measurement of all trunk duct and distributors between manholes and service boxes, as shown on the map, and all laterals, when a company goes into our subway, we figure the number of feet conduit, and number of feet laterals used, and charge them so much per foot conduit, and so much per foot laterals used.

A main feature of our subway is the fact that the electric light conduits and telephone conduits are side by side in the same trench, being separated by only six inches of concrete. The telephone ompany make strenuous objection to this on the ground that their ervice would be interfered with by being in the same trench with he electric light wires, but according to electrical experts, this is ot so. Mr. Walter C. Allen, electrical engineer of the District of olumbia, when written to requesting information as to the joint ccupation by electric light and telephone companies of conduits, eplies as follows: "I beg to state that each corporation operating n the district (with one exception), has its own system of underground conduits. The one exception is in the case of the Postal elegraph Cable Company, a portion of whose cables are in the ucts of the Potomac Electric Power Company. These ducts also ontain cables belonging to the latter company, and carrying voltages from 125 to 6,000. This department has also a few short engths of cables used for telephone and fire-alarm signal purposes n ducts of one of the electric lighting companies, in which there re also three wire Edison mains and cables for the series of arc ighting system. No attempt has been made to keep the different ystems of conduits on opposite sides of the street. They do not, owever, occupy the same trench, as they were built at different imes, but in certain sections they are as close together as it is possible to build them without one interfering with the other." From nother inquiry we learn that in other places, the telephone and lectric light companies use the same manholes, no interference ith the telephone company's service being experienced. Therefore, we are sure there will be no trouble of this kind in our subway, for both companies are separated, having as I have before tated, their own conduit, manholes, junction boxes and laterals.

In conclusion, I think it may be said that the experience derived o far from the practical operation of electrical subways has confirmed that it is possible to successfully operate all classes of electric conductors underground in cities. Mr. David R. Walker, chief f the Electrical Bureau of Philadelphia, says that after testing and aving in operation an underground system for the arc light wires, nd for telegraph and telephone service, his experience is that it an be made to work in a manner that will greatly improve the service. There is no doubt that the underground system is a great aving to telephone and electric companies in cost of maintenance

and absence of interruption to service. All the telephone a
graph companies in the larger cities, keeping up with the p
of the times, are putting their wires underground as fast as
ble and the cry seems to be at present, "The overhead wire
go underground."

Now comes the question, who shall own the underground
in our city streets? We own our own water system and
system, and I firmly believe we should own our own under
system for electric wires. The city streets are under mu
ownership, and I believe everything put under our streets
be under their protection also, for under municipal direction
tem can be built that will accommodate all companies, and th
the tearing up of our streets by every company that has ov
wires in our cities. There can be no loss to the city in a fi
way, for they can charge rental sufficient to meet every expe
curred. The cry at present seems to be municipal ownershi
of our lighting systems, and if this comes to pass, we want o
ways to put the wires into, so I am firmly convinced that the
ground system should be under our municipal government.


PROSPECT AVE
CITY LINE
BLOOMFIELD AV
AVE
ST
NORTH BRANCH OF PARK RIVER
ALBANY
CENTRAL NEW ENGLAND R.R.
TOWN OF BLOOMFIELD
CITY LINE
HARRISON AV
BLUE HILLS AVE
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VINE ST
ST
ST
ST
FLINT
GARDEN ST
ST
HARPER
WAVERLY
MARTIN ST
BARBOUR ST
BARBOUR
CLARK
AVE
TOWER AVE
TO

THE STORM WATER PROBLEM OF HARTFORD, CONN.

BY F. L. FORD, HARTFORD, CONN.

One of the greatest problems of the present age is the determination of the most scientific method of removing and disposing of the waste products of our rapidly developing American cities.

Much attention has been given by financiers, engineers, municipal officers and sanitary experts, and much money spent to solve these great questions which are continually crowding upon us; and yet these problems are in many of our cities far from a satisfactory solution.

While some cities have found and adopted the best methods applicable to their peculiar conditions, others are still in the dark and groping for the best scheme of overcoming their increasing municipal perplexities. No formula or scheme can be devised which is applicable to all of our cities, presenting such a variety of conditions. Much light has, however, been shed upon this subject, and valuable information diffused by different municipalities as they have studied and solved their own sanitary problems.

Law is fast being made by the courts of our own, as well as other states, in favor of the abandonment of the streams of our state as sewage carriers. Public opinion is rapidly developing into a condition where better methods will be demanded in providing for our waste materials, and the coming generation will not allow conditions to be perpetuated which we have tolerated in the past.

One of the greatest factors in the waste material problem, especially in densely built up sections of our cities, is the satisfactory removal of storm or surface water. It is, no doubt, the most expensive one, and unless operated in the most efficient manner, will certainly produce disastrous results, and give rise to expensive litigations. It is almost impossible to estimate the amount of damage that may be done by a cloud-burst in the heart of a great city, if the drainage channels designed for the removal of storm water are inadequate for its removal under such unusual conditions. The destruction to streets by the water with high velocity, which must flow off on their surfaces, if no room is available in the underground conduits, added to the destruction produced in flooded cellars and basements of commercial houses, where valuable stock is carried, is often underestimated.

The money used in repairing these streets and removing the stony material washed into catch-basins and sewers from their surfaces during the storms, thus helping to reduce what capacity the sewers were designed for, and in settling claims of aggrieved property owners for even one great storm, would go far toward providing additional capacity for our storm water sewers.

The inconvenience created by the flooding of cellars, and the sickness which may be directly or indirectly traceable to this cause, is hard to appreciate by those unaccustomed to such nuisances.

It is hard to realize, in a progressive age like this, how little has actually been done toward investigating a subject as important as this. One which may mean to cities an unwise expenditure for unnecessarily large sewers, if they are designed too large, or the unfortunate condition created by sewers which are too small. We are often influenced, if not controlled, by the facts that because a sewer of a certain size is large enough for a certain street, one of the same capacity is sufficient for a similar street, without thoroughly investigating exactly how much territory each is to drain, and find out too late, perhaps, that a blunder has been made.

The engineer, in designing a sewer system, usually knows the area to be provided for, the grades of the sewers to be built, and perhaps the intensities and duration of the severe storms in his vicinity. He should also be familiar with the general slopes of the districts, and know to a certain extent the permeability of the surfaces. But to know just what proportion of the storms should be carried off by the sewers in a given period, in order that the portion which is not removed shall do no damage, is a problem over the solution of which there is a great diversity of opinion and practice among engineers.

Mr. Howard A. Carson, a distinguished engineer of Boston, thoroughly familiar with sewer designing, in reporting upon the improved sewerage system of Cambridge, says: "The knowledge possessed by engineers as to the carrying capacities of sewers of various shapes, interior surfaces and inclinations, is reasonably satisfactory, and the knowledge as to the run-off of rain water from various city districts should be brought by careful observations and experiments to an equally high standard."

To my knowledge, this subject has been investigated in only three or four cases in this country, and in only one instance similar to the way we have started our experiments.

On December 15th, 1886, Mr. R. E. McMath, M. Am. Soc. C. E., read a paper before that society on the determination of the size of sewers in St. Louis. He used the following process in deriving his formula: $Q = Cr\sqrt[5]{A^4 S}$, which has been extensively used since its derivation, and one which Mr. Rudolph Hering recommended for use in Hartford, when he designed our intercepting sewer. He selected about 35 miles of sewers out of the 258 miles included in the St. Louis sewer system at that time, which were mostly larger than 2 by 3 feet, and drew a comparison between those which had proven adequate and those which had proven insufficient. In this manner he arrived at a standard below which they must not go.

In 1889 Mr. Emil Kuichling, M. Am. Soc. C. E., read a paper before that society on a similar work he carried on in Rochester, N. Y., for a period of one year. In pursuing his investigation Mr Kuichling used only standard rain gauges for collecting rainfall data, and observed in his paper as follows: "It is greatly regretted that none of these gauges were of the self-recording type; but the great expense connected with the purchase and maintenance of automatic gauges precluded the writer from availing himself of such instruments, and as a consequence it was found too late that only a few of the many records thus obtained could be used with reasonable certainty. The numerous observations and measurements of the rainfall and contemporaneous flood discharge of a number of large sewers which are given, will doubtless suffice to point out the necessity of securing the rainfall data needed in the consideration of the discharge from surfaces by means of automatic and selfregistering devices, instead of trusting to the judgment of even the most careful and well trained observers."

In 1889 observations were made by the Department of Public Works in New York, on the flow in a large sewer, and Mr. Rudolph Hering in this connection recorded, "the elements of sewers that were, and those that were never overtaxed, by the heaviest rains." Then by drawing a line between the plotting of the two results, he obtained the approximate capacity which the sewers ought to have.

Cambridge, during the past season, has been carrying on experiments similar to ours, but owing to the flat grades of many of the Cambridge sewers, they are experiencing considerable difficulty from the complete submergence of the automatic sewer gauges during some of the storms, which destroy the desired results.

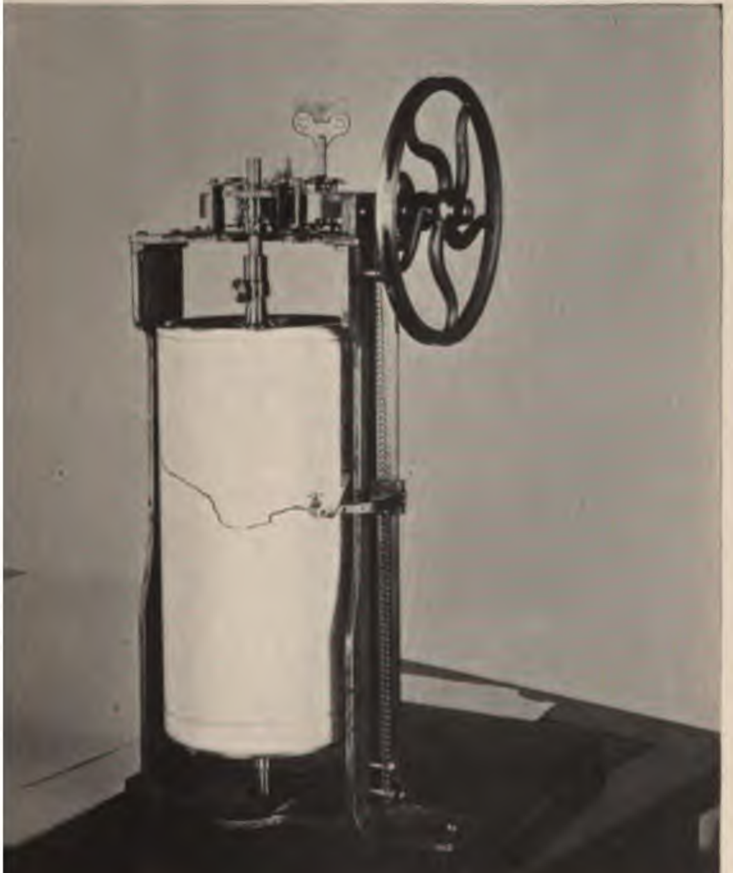
Outside of the above mentioned cases, I know of no similar work being carried on in this country.

In several sections of Hartford, during severe storms we experience considerable difficulty from surcharged sewers and cellar flooding, and the peculiar conditions connected with the Franklin avenue basin, one of our largest sewer districts, where this nuisance is prevalent, has justified the city of Hartford in starting the work I am about to describe. These conditions are such that they become aggravated as the section develops from a rural or sparsely built up section into a well built up section.

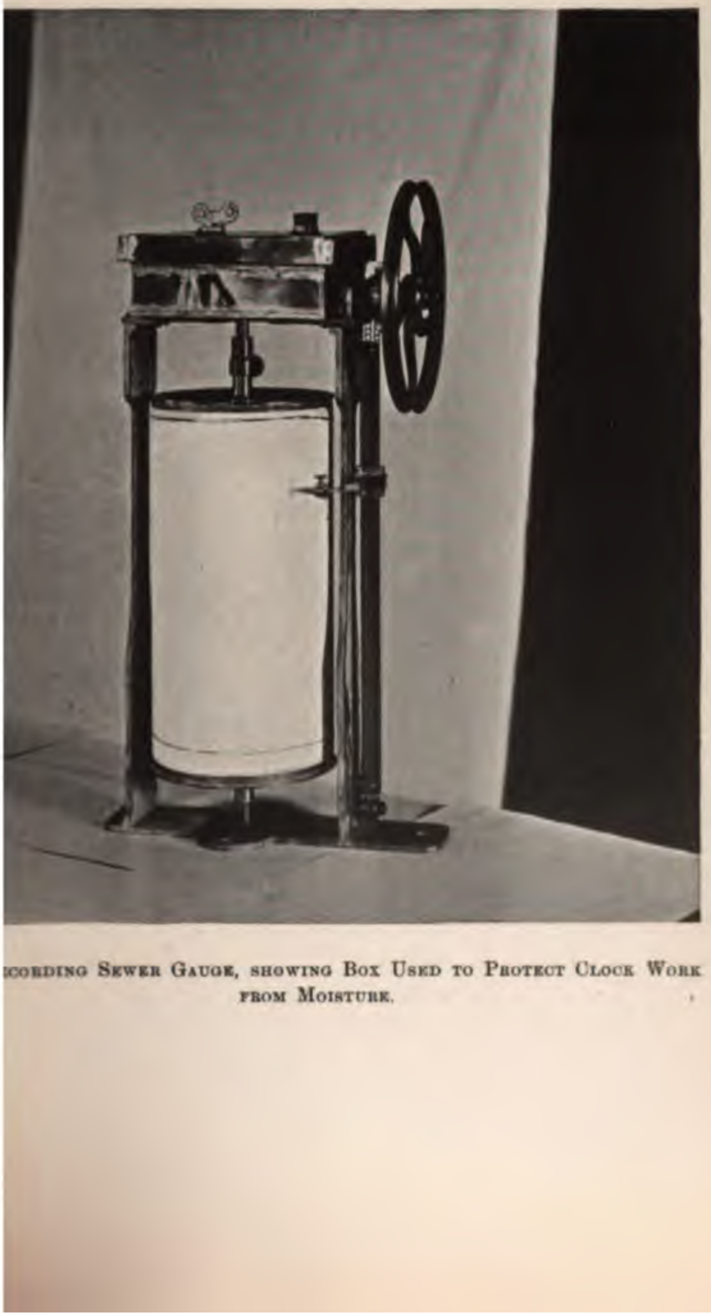
When our city was small and traffic light, this water naturally ran off in the gutters, as it fell, to the nearest water courses, doing little damage or inconvenience to anyone.

As the city develops, buildings increase, sidewalks are needed and paved streets required, and a large portion of the area which previously had been of an absorptive nature, retaining a certain amount of water or retarding its progress in its journey to the water courses, is changed to an impervious surface, not only preventing its absorption, but increasing its velocity to the drainage channels.

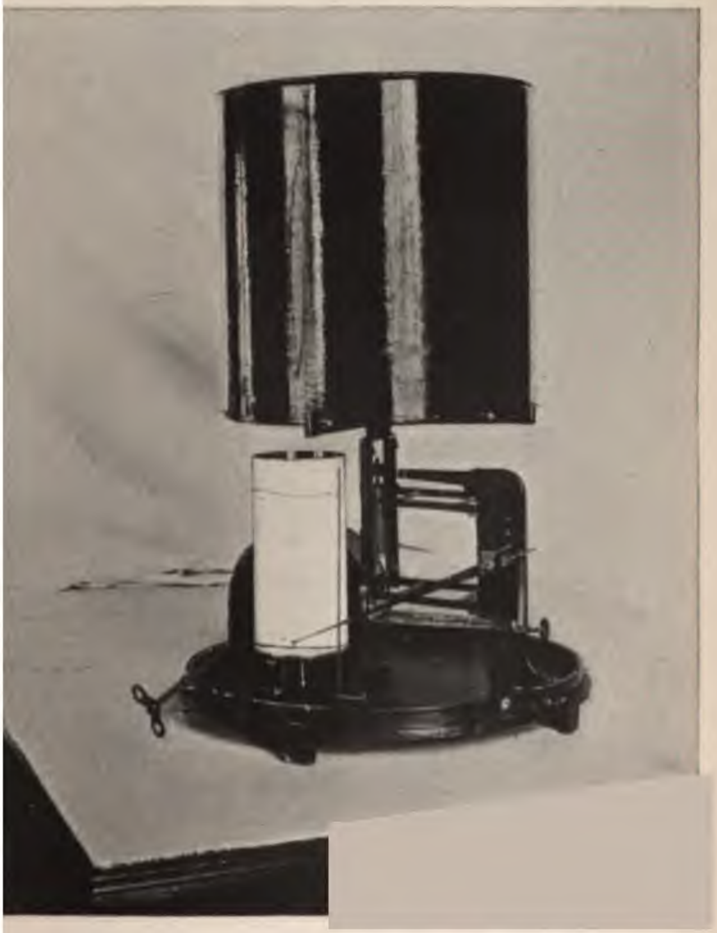
While the hydraulic engineer hails with delight the approach of a violent rain storm, especially in times of drought such as we have experienced the past two seasons, the sanitary engineer or sewerage designer, receives with not a little apprehension, the arrival of the unwelcome visitor, and breathes a sigh of relief if the storm



-Recording Sewer Gauge, used in the Storm Water Experiments at Hartford, Conn.



cording Sewer Gauge, showing Box Used to Protect Clock Work from Moisture.



cording Rain Gauge, with Hood Removed to Show Receiving Can and Inside Mechanism.

cording Rain Gauge, designed by S. P. Ferguson of Blue Hill Observatory, Hyde Park, Mass.

one of our [illegible] sewer systems, from which we receive complaints from cellar flooding. This work has been started the expectation that we shall not only locate the extent of this nuisance, but secure data which will materially assist us in designing a scheme for permanent relief from this trouble.

Before starting the experiments I am about to describe, I was anxious to determine just how our storms appear, and whether it was necessary to follow our work with the same degree of diligence

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asses without his telephone ear being burned out with the comlaints or grievances of deluged property owners.

The cloud-bursts we frequently experience are often aggravated y the season or condition of the ground or weather, and the resultg damage is greatly increased.

An eminent engineer, in reporting on the improvement of the werage system of a city, said: "The flooding of basements and llars depreciates the value of the property and endangers the lives those occupying the flooded dwellings. The offensiveness caused y sewage flooding drives away tenants. The damage done to roperty cannot be estimated by the soiled goods and injured walls, ut must be measured by the permanent prejudice created against e locality."

Few cities which are congested in any part are without expeences of this kind.

Anyone who lives on a street where the sewer becomes surcharged d floods the cellars during intense storms, can tell you why the nfortunate condition exists, but to the engineer who is called upon devise a scheme for permanent relief, it is often a serious and fficult problem to handle.

There are several places in the sewer system of Hartford where gorgements and cellar flooding are expected during unusually rd storms. This condition has come from the rapid development unexpected districts since the sewers were designed. Some of ese very sewers were considered entirely too large, and the buren excessive at the time they were built, but now they are consided too small to provide for the increasing demands made upon em.

During the past season we have commenced an investigation on e of our largest sewer systems, from which we receive many omplaints from cellar flooding. This work has been started with he expectation that we shall not only locate the extent of this uisance, but secure data which will materially assist us in designng a scheme for permanent relief from this trouble.

Before starting the experiments I am about to describe, I was nxious to determine just how our storms appear, and whether it was necessary to follow our work with the same degree of diligence through the whole of each year until we receive the desired data. To decide this question I have carefully examined and tabulated the records of 2,393 storms as recorded by Trinity College since 1872. While these storms were not measured by the modern automatic rain gauges, they furnish reliable data of the total amount of each storm, and give interesting information in the remark column.

From these records I find that we receive on the average 85.4 storms each year, which precipitate 46.46 inches. This comes closer to the state average of 46.03 inches than any other weather station in our state, reporting to the United States Government.

Seventy of our storms each year represent 45.4 per cent. of the total rainfall, and come in storms amounting to from $\frac{1}{100}$ of an inch to 1 inch; 11.6 storms, or 32.2 per cent. fall between the 1 and 2 inch limits; 2.7 storms representing 13.3 per cent. come between the 2 and 3 inch limits; .8 storms, equivalent to .06 per cent., precipitate from 3 to 4 inches each storm, and 0.3 of a storm, amounting to from 4 to 9 inches, equal to .03 per cent. of the yearly average.

From this deduction we may expect once in three years to receive a storm which will leave from 4 to 6 inches of water; about once a year one amounting to from 3 to 4 inches; 2.7 giving from 2 to 3 inches; 12 from 1 to 2 inches; and 70 below 1 inch.

Since 1872 we have had one storm, that of July 12-14, 1897, which precipitated 9.17 inches in about 35 hours.

From this list of storms I have selected most of those amounting to more than three inches, and examined them to find at what month of the year they fell, and have prepared a table showing the results. From the 26 storms tabulated I find only 5, or about 20 per cent., fell in the months of December, January or February, and one of these is recorded as rain and *snow*. This shows that the majority of our large storms do not fall during the season of freezing weather.

I have also separated the storms for Hartford into classes, representing thunder storms, snow storms, and others, and calculated the percentage of each for each month and year for the past 28 years. The yearly summary shows 15.5 per cent. to fall in thunder storms between March and December; 12.7 per cent. as snow, after melting, in the months of November, December, January, February, March and April; and 71.8 per cent. in storms not classed under these two heads.

The Franklin avenue basin where our experiments are carried on is in many respects a typical one for prosecuting a storm water investigation. The boundary lines are clearly defined, the slopes regular, and the whole area drained by one large outfall sewer. The whole district consists of about 1,167 acres, but we are at the present time only utilizing 477 acres located at the extreme northerly end of the basin.

In 1871 Franklin avenue was laid out and opened to furnish an outlet for a trunk sewer to drain this entire area.

Previous to this date only 8,550 feet of sewer had been built in this district, and the sewage from these sewers discharged on the ground at their outlets.

In 1872 and 1873 the Franklin avenue sewer was built at a cost of about $150,000.00. At this time there were only 230 houses on the district and about 1,700 people.

The Franklin avenue sewer is 6 feet in diameter from the storm water overflow at Folly Brook to Bushnell street, 4 feet from Bushnell street to Benton street, and 3 feet for the remaining distance to Maple avenue. It is circular throughout, and built on a grade of 2 and 3 feet per thousand feet.

The whole cost of this sewer was levied on the property between Wethersfield and Fairfield avenues, and the burden was so excessive that some of the property has not recovered to this day, and many liens placed on the land at that time have never been discharged. The lower part of the district has recovered very slowly, and remains in practically the same condition as it was in 1872. The development of the upper part has been a strong, healthy one, and the buildings have been crowding down farther each year. The lower limit of the well built up section in 1872 was at Alden street. Today it is at Bond street, and there are many houses below this limit in the vicinity of Brown street and Standish street. While the expansion of the upper end of the basin has been uniform, that of certain sections has been spasmodic. The section between Winship and George streets and Brown and Preston streets had only

15 houses in 1896. Today there are 60 on the same area, sho a growth of 75 per cent. a year for the past four years, which phenomenal record for any part of Hartford.

The gradual change in the character of the district above B street, from a sparsely or rural to a well built up residential tion, has brought with it difficulties which were not dreamed of 1872. The surface water which the Franklin avenue sewer supposed to provide for at all times, now reaches the sewer in voluminous quantities during severe storms that the sewer is large enough to carry it, and for a short period it is either obli to remain on the street surface or is forced back into the cellar buildings adjacent, doing considerable damage and great incon nience to the afflicted properties.

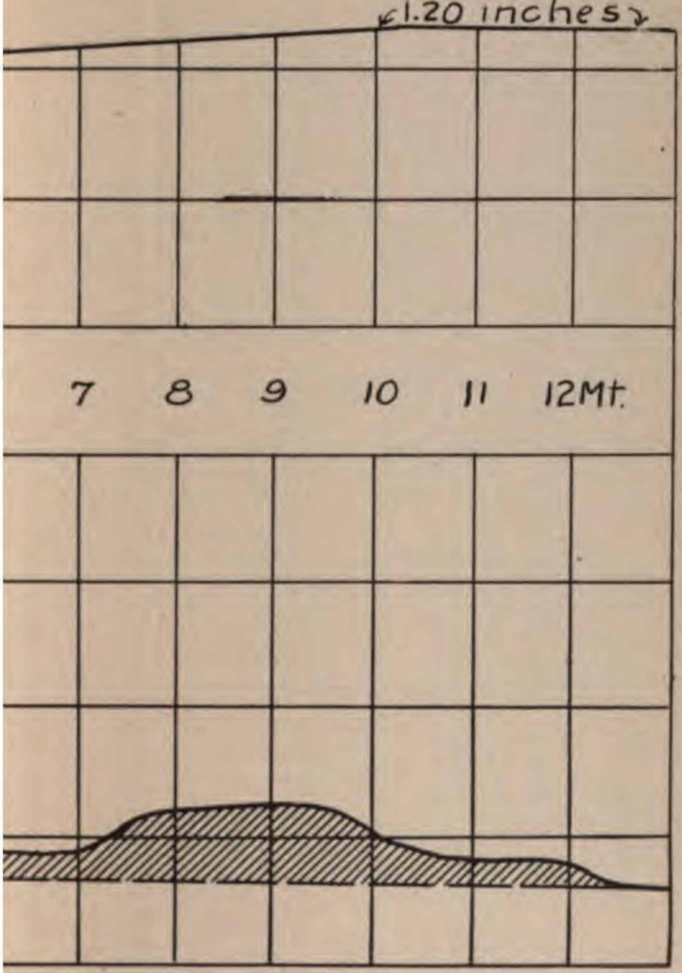
Today there are 5 miles of brick sewers; 5.3 miles of tile sewe and 4.7 miles of tile house connections, making a total of 15 mi of main and lateral sewers, contributing to the trunk sewer ab South street.

There are 773 houses on the area, 544 above and 229 below Be street, and about 5,720 people in the entire district.

In collecting the rainfall data for our use, three automatic r gauges made by S. P. Ferguson, of the Blue Hill Observatory Hyde Park, Mass., are used, and three standard gauges to ch the automatic gauges or measure the total precipitation, if for reason the self-recording machines fail to operate. These gau are located triangularly around the basin, and in such a man that whatever direction a storm approaches from, or how wide storm area, one or more of the three gauges will not fail to rec its intensity, duration and amount.

One pair of these gauges is placed on top of City Hall, ano on New Britain avenue near Fairfield avenue, and the third Wethersfield avenue at the corner of Jordan lane. Their posi and relation to the experimental district is shown on Figure 1.

We assumed in starting this work, that as the storms whic the greatest damage are very infrequent, and thunder shower decidedly local in their nature, it was very essential that we three pair of rain gauges, located around the district, rather trusting to one pair. The wisdom of this decision has been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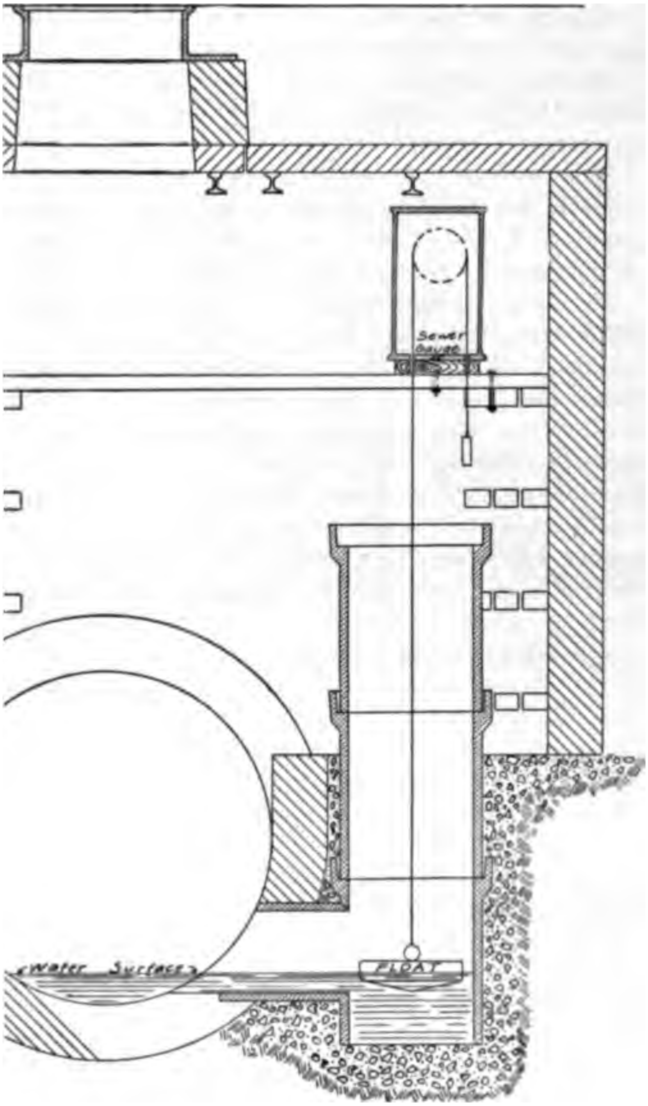

FIGURE 2.
ection of Special Sewer Gauge Manhole, showing position of Gauge and Float.

verified in several cases. Already we have had differences of 25 per cent. in the amount measured by the City Hall gauges and those located on Jordan lane, and we fully expect in the thunder shower season to obtain differences of 100 per cent. in the three sets of gauges.

The two automatic sewer gauges used to record the depth of water in the Franklin avenue sewer during storms are located as shown on Figure 1, one at the corner of Bond street and the other at the corner of South street and Franklin avenue.

Bond street divides the district nearly in the center, there being 263.5 acres above and 213.5 acres below it, and is the southern boundary of what may be called a well built up residence section. Below Bond street the houses are sparsely located on most of the area, so that there is a decided difference in the character of the areas on either side of Bond street. For this reason we believe the two sewer gauges are wisely located, the one at Bond street giving us the amount of water running off from a well built up residential section with a large percentage of impervious surface, and the difference in the readings of the two gauges giving us the water from the area below Bond street, which is sparsely built up, and has a very small percentage of impervious area.

These sewer gauges are operated in special manholes built for the purpose, as shown in Figure 2, and cost about $75 each. The cylinders which carry the record sheets are run by an eight-day clock, and revolve once in 24 hours. Blank sheets of paper are used and the time and depth of flow when the machine is started are noted on the paper. After every hard storm the records are transferred to nigrosine prints made from a tracing, having the time of the clock and vertical travel of the float marked on it.

The records of one or two storms taken from both rain and sewer gauges, as shown in Figure 3, illustrate what sensitive indices the sewer gauges are, and how quickly slight fluctuations in the depth of flow, caused by changes in the intensity of the storms, are recorded by the sewer gauges.

Flood boards are used in the manholes above South street about every 300 feet to record the highest points reached by the water the sewer at these points during the storms. These marks furni

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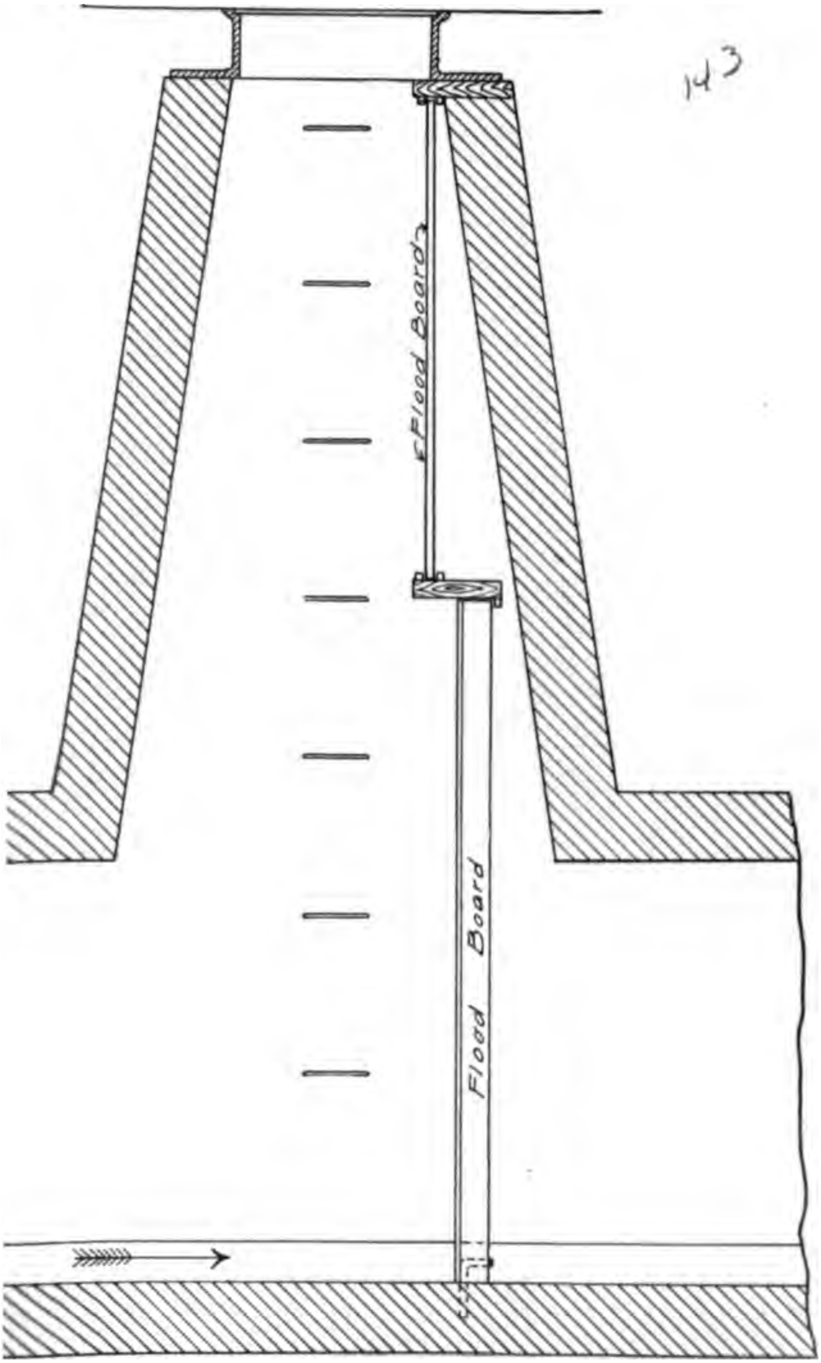


FIGURE 4.
Cross Section of Flood Board Manhole, showing position of Flood Boards.

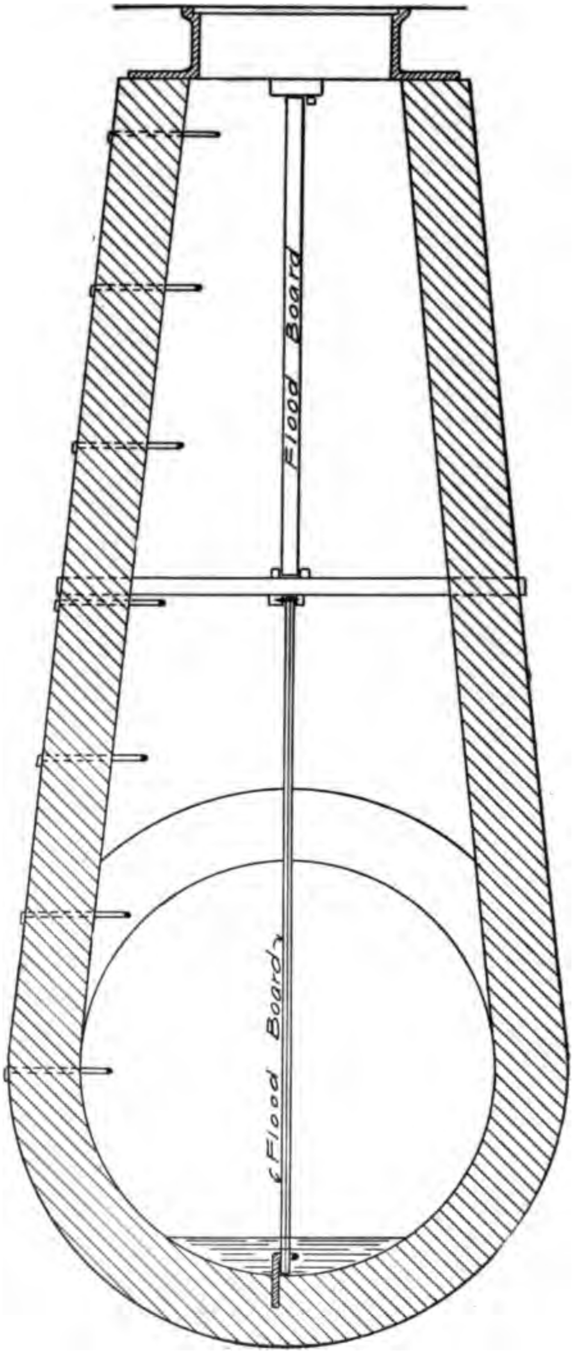
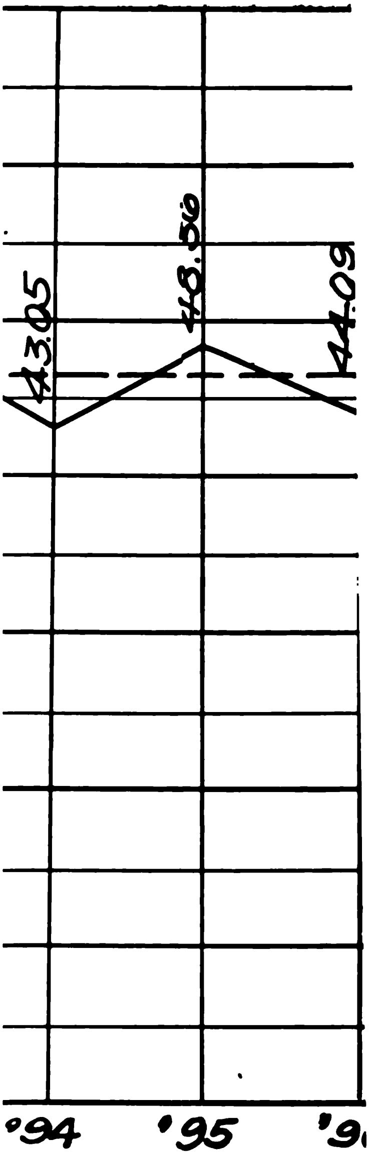


Figure 5.

Transverse Cross Section of Flood Board Manhole, showing position of Flood Boards.


43.05
48.56
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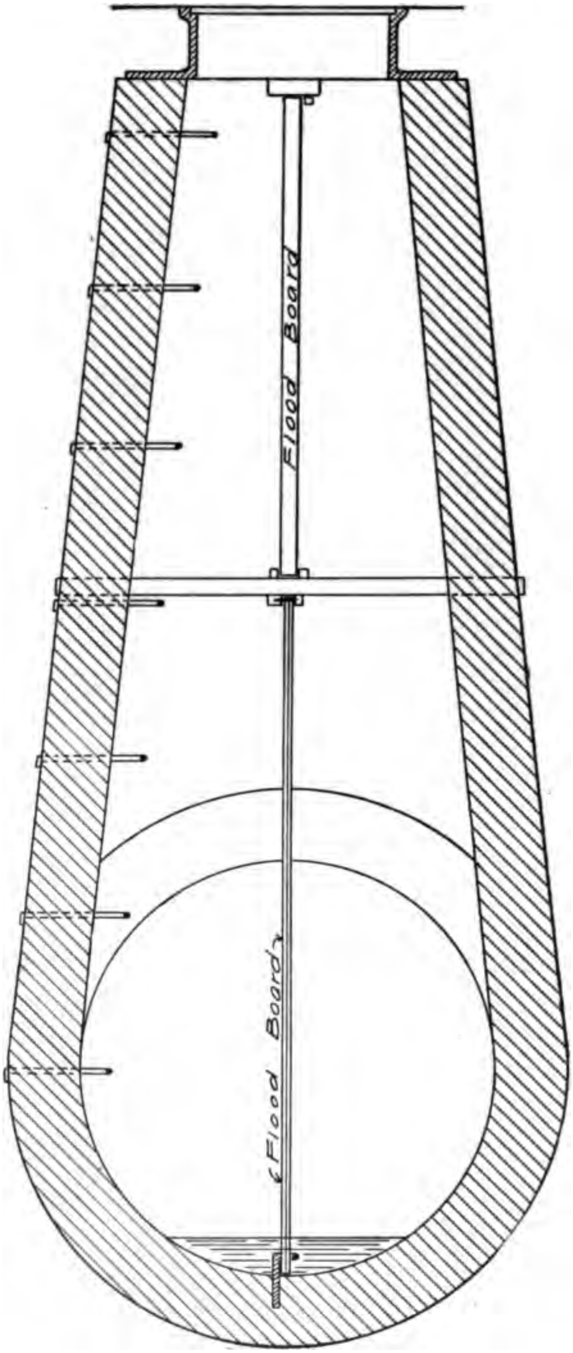
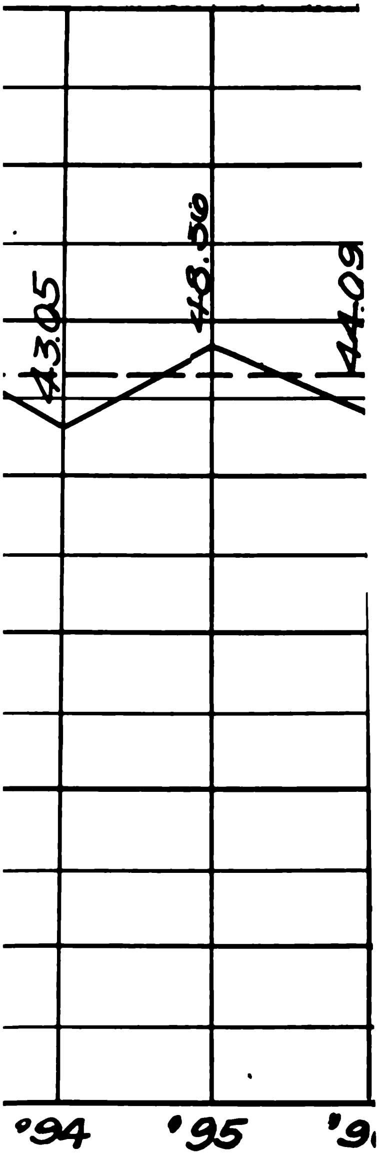


FIGURE 5.
Transverse Cross Section of Flood Board Manhole, showing position of Flood Boards.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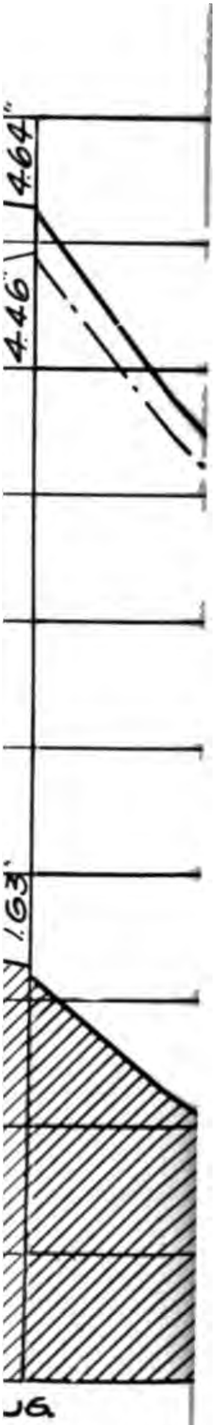


ed), and ordinary
snow areas what

the hydraulic grade line of the sewer, which is used in calculating the amount of water passing the sewer gauges.

A profile of the avenue has been made with a horizontal scale of 100 feet and a vertical scale of 10 feet to the inch, and the elevation of every cellar placed on it. Nigrosine prints of this profile will be made, and the hydraulic grade line of each storm placed on these sheets for permanent records, which may be used to advantage in defending the city in damage cases by aggrieved property owners.

These experiments will be continued in the Franklin avenue district for several years, or until we have records from a great variety of our hardest storms, under favorable conditions for maximum run-off. We hope to start similar experiments on the Broad street basin, which is very similar to the Franklin avenue district, and is already slightly congested. This work will be followed by experiments on smaller areas in the heart of our city, where all streets and alleyways are paved with improved paving and buildings cover all available building areas.

From these districts, representing so many conditions, regarding their imperviousness, slopes, buildings, etc., we expect to arrive at definite conclusions concerning the amount of storm water to provide for, which will amply repay us for all money and labor expended in our work.

I hope at a later date to present a paper to this society giving in detail the final results of our experiments, which I believe will be of inestimable value to the members of our society called upon to design sewers for the removal of storm water.

Table No. 3.

RAIN STORMS IN THE PAST 28 YEARS AT HARTFORD, CONN., IN WHICH THE TOTAL AMOUNT PRECIPITATED HAS EQUALLED OR EXCELLED 3 INCHES.

Year.	Month.	Am't.	Duration of Storm.	REMARKS.
1897	Aug.	9.17 in.	34½ hours, from 10 p. m. of 12th.	Thunder showers, 5.10 inches in 3 hours, 6.82 inches in 24 hours.
1879	Aug.	5.84 "	71 " " 3 a. m. " 16th.	Rain storm, 3 a. m. to 3.45 p. m. of 18th, 1.71 in.; 3.45 p. m. of 18th to 2 a. m. of 19th, 4.13 in.
1894	Sept.	4.74 "	22½ " " 9 a. m. " 19th.	Rain storm.
1886	Feb.	4.63 "	48 " " 2 p. m. " 10th.	Rain storm.
1898	Feb.	4.50 "	18 " " 8 p. m. " 20th.	Rain storm.
1888	Jan.	4.44 "	18 " " 1 a. m. " 1st.	Rain and snow.
1890	July	4.09 "	23½ " " 1.30 a. m. " 25th.	Thunder shower.
1895	Oct.	3.99 "	23 " " 1 a. m. " 12th.	Rain storm, 2.60 inches in 24 hours.
1891	Sept.	3.93 "	52½ " " 8 a. m. " 5th.	Rain storm, 2½ inches in 16 hours.
1877	March	3.84 "	73 " " 7 a. m. " 26th.	Rain storm.
1900	March	3.83 "	14 " " 8 a. m. " 1st.	Rain storm; on ice surface; flooding of all sewers.
1900	Nov.	3.60 "	61 " " 8 p. m. " 24th.	Cold N. E. rain storm.
1876	March	3.56 "	22 " " 5 a. m. " 25th.	Snow turning to rain and a tremendous N. E. storm.
1897	Dec.	3.53 "	24 " " 9 a. m. " 14th.	Rain storm.
1887	June	3.51 "	46 " " 8 a. m. " 22nd.	Thunder showers followed by heavy rain.
1889	Nov.	3.45 "	20½ " " 2.30 p. m. " 27th.	Rain storm.
1876	July	3.44 "	14 " " 2 p. m. " 30th.	Rain storm.
1882	Sept.	3.43 "	18½ " " 7 p. m. " 23rd.	Rain storm.
1877	Oct.	3.40 "	20 " " 7 a. m. " 4th.	Rain storm.
1899	July	3.37 "	14 " " 9 a. m. " 8th.	Thunder showers.
1880	July	3.35 "	5¼ " " 5.45 a. m. " 20th.	Thunder showers.
1893	May	3.29 "	48 " " 7 p. m. " 2nd.	Rain storm.
1895	Aug.	3.25 "	3½ " " 7.30 a. m. " 7th.	Thunder showers.
1897	July	3.18 "	24 " " 8 a. m. " 28th.	Thunder showers, 2.82 inches in 11 hours.
1878	Dec.	3.08 "	28 " " 4 a. m. " 9th.	Snow turning to rain; a furious S. E. storm.
1878	March	3.00 "	18 " " 7 p. m. " 20th.	Snow turning to rain.

TABLE No. 4.

SNOW TABLE, MEASURED AS IT FELL ON THE GROUND (NOT MELTED).

DECEMBER.				JANUARY.				FEBRUARY.			
Year.	Inches.	Year.	Inches.	Year.	Inches.	Year.	Inches.	Year.	Inches.	Year.	Inches.
1788	13.5	1888	1.1	1788	14.0	1888	17.2	1788	9.0	1888	56.5
1789	11.0	1889	5.7	1789	28.0	1889	4.5	1789	10.0	1889	3.7
1790	9.5	1890	7.9	1790	12.0	1890	2.8	1790	11.5	1890	2.5
1791	18.0	1891	0.0	1791	20.0	1891	13.2	1791	17.0	1891	11.0
1792	6.5	1892	1.1	1792	20.0	1892	15.1	1792	12.0	1892	7.5
1793	7.0	1893	16.8	1793	8.0	1893	12.0	1793	18.0	1893	31.1
1794	22.0	1894	11.5	1794	15.0	1894	11.0	1794	14.5	1894	26.0
1795	1.0	1895	2.0	1795	10.0	1895	17.0	1795	17.0	1895	13.0
1796	8.0	1896	11.0	1796	26.5	1896	9.0	1796	17.0	1896	11.0
1797	8.5	1897	9.5	1797	5.5	1897	27.0	1797	3.5	1897	10.5
1798	0.5	1898	7.0	1798	14.0	1898	17.0	1798	8.0	1898	7.0
1799	16.0	1899	1.0	1799	13.0	1899	7.0	1799	24.0	1899	32.0
1800	6.0	1900	1.5	1800	1.0	1900	6.5	1800	13.5	1900	14.5
Totals	127.5		76.1		187.0		159.3		175.0		226.3
Average	9.31		5.85		14.38		12.25		13.46		17.41

Total for December, January and February, 1788 to 1800 inclusive, 37.65 inches.

Total for December, January and February, 1888 to 1900 inclusive, 35.51 inches.

TIME ELEMENT IN LABORERS' WORK.

BY G. A. PARKER, SUPT. KENEY PARK, HARTFORD, CONN.

In most construction work the cost of common labor is one of considerable proportions. At this time I shall consider only so much of that labor as relates to loading and unloading carts and carting.

A not unusual method is to put to work such men as seem willing and able. To place over them a boss whose duty is to keep the men continually at it. Under this method it has been found that eight, ten or twelve yards per day is all that can be counted on, and I doubt if any contractor would dare estimate as high as fifteen yards a day per man. So when I make the statement that the men at Keney Park load twenty or more yards per day, an expression comes into the listener's face as if he thought I might want to tell the truth, but I certainly must be mistaken, and when I add that they are not as tired loading the twenty yards as they are in loading the twelve by the old method, they are apt to look towards the south, as if they expected to appear a keeper from Middletown to capture an escaped inmate.

I come before you today to make such statements and explanations of this work as I believe to be true, appealing to you as men of greater knowledge than I possess in such matters, and hoping you will find the method reasonable, and feeling sure that you will not credit me with trying to make startling statements.

Three years ago, during a sleepless night, the thought of how the Time Element in loading carts could be used to the advantage of both the workmen and the park came to me in a very crude way. The next morning, with a shovel and a half bushel measure, I experimented a little by myself, arriving at certain conclusions, which I put to a test in loading teams. I will not tire you with the incidents and the mistakes of the experimental stages, but will state at once, as nearly as I can, the result of the three years' work by this method, and in hopes of making it more definite I will use as an illustration a case where everything is favorable to the method.

GIVEN:

First—The cut, a bank of sand, so loose as to need neither picking or plowing.

Second—Plenty of room so teams can drive onto the bank and the men can load from both sides and the rear.

Third—A cubic yard to make a load.

With the conditions as given the work is arranged as follows:

As it takes 150 shovelfuls of sand to make one cubic yard, and as each man puts in five shovelfuls, 30 men would seem to be the number needed, but I find that about 1-20 of a man's time is not efficient, so for every 20 men theoretically needed, I add one man, that is, I put 21 men to do 20 men's work, and the extra man not needed becomes the most profitable in the crew.

The time allowed for putting in the five shovelfuls is 50 seconds, which averages one shovelful to 10 seconds, but the actual time used is only 15 to 30 seconds. Practically, each man works 25 seconds and rests 25 seconds, and so alternates through the entire day. This is the secret of the success of this method of loading: to work quickly for a few seconds, then to have an absolute and an unquestioned right to an entire rest. A man can work as his heart beats, that beats continually during the 24 hours, yet it rests between every throb. Neither the man nor the heart can work continually without rest.

While a man can put in 5 shovelfuls in 50 seconds, yet it does not follow that he can put in 6 shovelfuls in 60 seconds, or 10 shovelfuls in 100 seconds and follow it all day, much less to follow it day after day. Five shovelfuls in 50 seconds seems to be the limit. If there is room to work the men, 4 shovelfuls in 40 seconds is better. I believe this short, quick work, alternating with short complete rest, is a physiological fact which must be recognized to obtain the best results and leave the workmen in the best condition.

One works quickest in the morning, faster but not so quick as in the morning after dinner, and the slowest at night. If Sunday is a day of rest, then Monday is his best day and Saturday his poorest, with weather conditions modifying them all.

No man should work so hard one day as not to feel rested the next morning, and no week's work should be so laborious but what Monday morning finds him fresh and eager for his work.

Five shovelfuls in 50 seconds, after deducting 5 per cent. allowed for waste time, means 22 4-5 yards for 10 hours' work, and this is our record day after day for sand shoveling, and no laborer stays with us who does not readily accomplish this for a day's work. During the experimental stage of this method the men frequently shoveled 30 yards per day, or 5 shovelfuls in 40 seconds, while this is not difficult for one day, it was found they could not do it day after day, and I think the lesser number is the limit for continuous work.

I have said the men were not more exhausted in loading the 22 yards than they were in the 12 yards by the old method, but this fact is not due entirely to the alternating of work and rest. I am not sure as this has much to do with it, except indirectly.

My observation has led me to think that the man who loads 10 yards alone, or is one of 5 loading 12 yards apiece, or is one of 10 loading 15 yards each, or is one of 30 loading 22 yards for his days' work, has about the same degree of tiredness at night. If muscle was the only element which enters into the loading then this would be impossible, while without physical strength shoveling cannot take place, yet given that strength then the spirit of the work has as much to do with getting tired as the muscle. When he is alone he has only his own spirit, but as one of five or ten he not only has his own spirit, but that compositive spirit which comes when many are united for a common purpose, be that purpose the loading of a cart or the conducting of a prayer meeting.

Five men will fill five carts much quicker if they all load into one cart and fill them in succession than if they each loaded a cart alone by himself. This is a psychological fact that deserves much consideration in carrying out large contracts.

Then again, by the Keney Park Method, if I may call it such, in addition to his muscular strength and composite spirit of numbers, he has another element which lessens the exhaustion of his work, in that it requires a greater mental activity. The laborer's mind is apt to become quite dormant during his working hours, for he has little occasion to think in the constant repetition of doing the same thing over and over again. The yelling of his boss, the directions of the engineer, the presence of the contractor or the proprietor, quickens the work and lessens its burden, not from the sense of fear, as many suppose, but because it stirs the thoughts in the man. A slight accident, a difficulty to overcome, a dog fight, a hand organ, or anything which quickens the brains, increases the work with less weariness.

The Keney Park Method requires more thought; he must count his shovelfuls, for he is as liable to be discharged for putting in one shovelful too many as one not enough. He is an integral part of a system and must do his work, and do it quickly, for 50 seconds is not long. He knows each man is doing the same, there is no shirking. If he does his part his place is secure, if not, he is sure to go, he stands in his own integrity and worth, another's shortcomings do not injure him. Competition comes in, for no one wants to put in the last shovelful. All in all he becomes interested in his work, and so it is not drudgery.

Many interesting questions could be discussed right here, as to the capacity of shovels, the foot-pound load, how the system is modified when clay or gravel, or picks or plows are used, etc., but there is not time, the team work must now be considered.

The arrangement of teams is very simple. Whatever the loading time may be, a cart must enter the pit exactly that length of time apart. I determine the number of teams needed as follows: On one of the spokes of the front wheel of the buggy a piece of twine is wound around several times, and by counting the number of revolutions by traveling over whatever route the cart may take, multiplying by 11.05 feet, the circumference of the wheel, the distance the cart may travel in all its windings is determined. Divide the distance by 3, the number of feet per second, if the team travels 20 miles per day, which I consider a day's work, and it gives the number of seconds for the round trip, and this quotient, divided by the loading time in seconds, gives the number of teams needed for that run. To illustrate: Given a run of one-quarter mile of 1,320 feet and the loading time 50 seconds. Thus: 1,320 divided by equals 440, the number of seconds of the round trip, which divide by the loading time, 50 seconds, gives 8.8 or 9 teams needed fo such a route. In practice it is not necessary to go through thi process for knowing the circumference of the wheel; a certai number of revolutions means a team.

In the following table I will illustrate further how it works:

40	seconds	loading	teams,	120	feet	apart,	44	teams	per	mile.
50	"	"	"	150	"	"	35	"	"	"
60	"	"	"	180	"	"	29	"	"	"
70	"	"	"	210	"	"	25	"	"	"
80	"	"	"	240	"	"	22	"	"	"
90	"	"	"	270	"	"	20	"	"	"
100	"	"	"	300	"	"	18	"	"	"
110	"	"	"	330	"	"	16	"	"	"
120	"	"	"	360	"	"	15	"	"	"
150	"	"	"	450	"	"	12	"	"	"
180	"	"	"	540	"	"	10	"	"	"
210	"	"	"	630	"	"	8	"	"	"
240	"	"	"	720	"	"	7	"	"	"
300	"	"	"	900	"	"	6	"	"	"
600	"	"	"	1,800	"	"	3	"	"	"

The following table shows the number of seconds loading time, the number of loads carted per day, number of loaders needed, and the number of cubic yards loaded by each loader:

40	seconds	loading	900	yards,	40	loaders,	22½	yards	each.
50	"	"	720	"	32	"	22½	"	"
60	"	"	600	"	29	"	21	"	"
70	"	"	514	"	26	"	20	"	"
80	"	"	450	"	23	"	20	"	"
90	"	"	400	"	20	"	20	"	"
100	"	"	360	"	19	"	19	"	"
110	"	"	327	"	18	"	18	"	"
120	"	"	300	"	17	"	17	"	"
150	"	"	240	"	16	"	16	"	"
180	"	"	200	"	13	"	15	"	"
210	"	"	171	"	12	"	14	"	"
240	"	"	150	"	11	"	14	"	"
300	"	"	120	"	9	"	14	"	"
600	"	"	60	"	5	"	12	"	"

The following table gives the cost per cubic yard at the different times it takes to load a team, on the supposition that the proper number of men are allowed for the loading in the given time:

40 seconds loading, $6\frac{2}{3}$ cents per yard.
50 " " $6\frac{2}{3}$ " " "
60 " " $7\frac{1}{4}$ " " "
70 " " $7\frac{6}{10}$ " " "
80 " " $7\frac{7}{10}$ " " "
90 " " $7\frac{1}{2}$ " " "
100 " " $7\frac{9}{10}$ " " "
110 " " $8\frac{3}{10}$ " " "
120 " " $8\frac{1}{2}$ " " "
150 " " 10 " " "
180 " " 10 " " "
210 " " $10\frac{1}{2}$ " " "
240 " " 11 " " "
300 " " $11\frac{1}{10}$ " " "
600 " " $12\frac{1}{2}$ " " "

These tables show that by simply taking advantage of certain physiological and psychological principles inherent to every workman, his work is increased 10 yards per day and the cost of loading reduced from $12\frac{1}{2}$ cents per yard to $6\frac{2}{3}$ cents. These same principles are taken advantage of when men work together in large shops, enabling manufacturers to produce their goods so cheaply. This is simply an application of an old principle to laborers' work.

The greatest gain comes with the loading time not exceeding 1 minute and not less than 40 seconds. If the loading time is over 2 minutes, there probably is but little, if any, gain with the shovelers, although there still remains a substantial gain in the carting.

If the loading time exceeds 2 minutes the cost of carting immediately increases, for the pay is just as much when the team stands still in the pit being loaded as when walking. Most teams walk at the rate of from 24 to 25 miles in 10 hours, but after many trials I have concluded that a team should not be required to walk over 20 miles per day, or 176 feet per minute. It is a slow team which walks only 200 feet per minute. Most go 210 to 220 feet per minute. This variation is not only sufficient to allow for loading and dumping, but it gives each team 2 or 3 minutes' rest before it enters the pit, and this rest is needed by the horses, for when it enters the pit for its load, there is practically no stopping until it reaches the pit again. At the dump there are four men, one at each corner of the cart, to pull the tail-board, to unhook and dump the cart and hook it again, and more carts go through the pit without stopping than stop.

To begin with I was doubtful if the men could endure this increased work, but never gave a thought but that the teams and drivers could. It is the unexpected that happens. The men stood it easily, but the teams played out until they were allowed to rest just before entering the pit, and the driver, who had no opportunity to leave his seat, had the hardest time of all.

The cost of teams standing in the pit by the old method is a large item in the expenses. Supposing the haul is a thousand feet and 5 minutes in loading, then the cost of the teams standing in the pit, of no use as far as the work is concerned, is as great as the cost of cartage.

Again, suppose that the driver loads his own team. Few drivers will load 15 yards per day, but allowing they do this, then it takes 40 minutes to load up, which at $4.50 per day for team, costs 30 cents, of which about 10 cents is for the man's work and 20 cents is for the horses standing still doing nothing.

Again suppose there are 5 men loading, a common number, which nevertheless, takes 10 minutes then it costs 12½ cents for the men's loading and 5 cents for the horses standing still, 17½ cents in all. *The cost of the horses standing in the pit should be added to the loading and not to the carting.*

With 5 men loading and 1000 feet haul the team works just one-half the time. If the haul is less than 1000 feet the team works less than half the time.

Supposing 10 teams are at work at a cost of $45.00 per day and the haul is 1000 feet with five men loading, then by the Keney Park Method the same amount of carting could be done with half the teams or twice the amount of carting with the same teams and not overwork the horses. In that item alone there would be a saving of $22.50 per day, not a net gain, however, for other expenses come in, but easily a net gain of $15.00 a total saving not to be sneezed at on a job of that size. By the Keney Park Method the cost of carting is reduced to its lowest time element.

The method of management to make this practical is very simple and works almost automatically, yet it was not established without some difficulty.

The method is this: A schedule of the running time is known, and the men and teams on hand, the teams are numbered.

A timekeeper is employed who stands, watch in hand, at the entrance of the pit. He has a block of paper ruled especially for the purpose, and as the team passes him puts down its number, the hour, minute and second it passes, then at the end of 50 seconds, if that is the running time, another team passes and is recorded, and so on without stopping through the day.

There are from 3 to 5 teams waiting to enter the pit except at the time of watering.

It is found that 15 men is all that can load at one time into a cart, so the loaders are divided into crews of not over 15 each, the team passes the timekeeper to the first of these crews where it stands about 25 seconds, starting up just as the last shovelfuls are put in, comes to the second crew and the third, if there be one, then out onto the fill and back to wait its turn for the next load. Usually they are a little over a minute in going through the pit. One half minute is allowed at the dump, but it is seldom needed. A minute and a half to two minutes is all that is needed for unloading, which is balanced by the faster time a team walks if the route is 500 feet and nearer than that it is cheaper to use the scraper.

Either a two or four horse plow is used to keep the material loose for shoveling, and except in heavy clay one plow is enough for a string of teams, picks being used only in corners, a foreman and a water boy is also needed.

Such is the outline of this method not practicable in all nooks and corners, but entirely practical where large work is going on, and in more places than at first might appear.

At first it seems ridiculous to think of seconds in loading and carting, but in practice it is found the thing to do. If the time is 50 seconds then 720 loads is a day's work, if the time could be reduced one second then 16 loads more would be moved, and if to 40 seconds 180 yards would be added, and it is practical to run in 40 second time.

No system will run itself, it depends upon the efficiency of the foreman and the man behind the shovel. Neither is this easy to apply at first, although it is simple to carry out after once established. It takes courage at 7 o'clock in the morning to see 30 teams standing in a row like a funeral procession, and 30 odd men standing leaning on their shovels waiting for time. The 25 seconds which the men wait then seems 25 minutes, and the desire is to send the teams in as fast as possible till the thing is started. and then adjust the time. But that would be fatal to the purpose. for if the men are crowded the first half hour they will not recover from it all day. It would pay better to increase the time at the very beginning.

I would not blame you if you thought all this in the air, so I will tell of its application outside of the park, in which I had no part.

The first of last month when the park was stopping work and laying off men, two of the park employees, who were familiar with this method of work, took a grading contract of $25 less than the next lowest bidder. It consisted of moving 1,100 yards of material, cutting two good sized trees, digging several stumps, and smoothing the whole when completed. Their bid was $225, practically 20 cents per yard. Part of it could be moved with scrapers, about one-third, and half the remainder at an average cartage, usually of 600 feet. Three-fourths of the fill was in a muck hole. During the time there was a day's rain, and much of the remainder the weather was decidedly unpleasant, a drizzly rain.

They completed the work in 2½ days at a cost, including everything paid out for the work, of $122, leaving $123 for their own time of 2½ days. The smoothing of the ground cost $11. I do not know what the cost was for the trees and stumps and incidental work, but counting that in with the moving of the earth, it makes it pay a fraction of a mill over 10 cents per yard. The actual cost of the work was probably a little over 9 cents per cubic yard measured in the cut. Does any one here suppose it could have been done by the old method at any such price?

In conclusion, allow me to say I had no desire to inflict upon you the reading of this paper, but a year ago I was asked to make a statement of this work, and declined. This year I was again asked by several of your members to do so, and accepted, my only excuse for doing so today.

A DESCRIPTION OF THE 24-INCH VITRIFIED PIPE CONDUIT, HARTFORD WATER WORKS.

BY W. E. JOHNSON.

During the fall of 1899 the Water Commission of Hartford decided that some step must be taken to prevent the loss of water from the canal connecting reservoir No. 6 with the distributing system. Two plans were considered, viz.: That of lining the canal with some impervious material, and that of laying a line of pipe connecting reservoir No. 6 with the lower reservoir.

A somewhat lengthy investigation of both plans ended in a decision in favor of a 24-inch vitrified pipe conduit.

Two routes for the pipe line suggested themselves, in the one the pipe was to be laid in the bed of the canal with a grade of $\frac{6}{10}$ of a foot per 1,000 feet, this being the grade of the canal.

The other route considered, and finally adopted, was somewhat longer than the first, and planned to utilize the entire fall of 50 feet between the effluent pipe at reservoir No. 6 and the flow line of reservoir No. 5. The length of this line was 16,700 feet, and the grade $2\frac{98}{100}$ feet per 1,000 feet.

The following abstracts from the specifications will suffice to show the kind and quality of pipe required for the conduit:

SPECIFICATIONS FOR FURNISHING 17,000 FEET, MORE OR LESS, OF 24-INCH SALT-GLAZED, VITRIFIED CLAY PIPE.

The pipe shall be of the kind usually known as socket pipe, and it shall be made of the best quality of salt-glazed, vitrified clay.

The pipe will be inspected as it is unloaded from the cars at Hartford and it shall conform to the following requirements and conditions: A deficient pipe that has passed this inspection will until the final adjustment and completion of the contract at any time be liable to rejection when discovered. Each pipe shall be straight throughout its length, and have an internal diameter of 24 inches.

At least 50 per cent. of all pipe in each shipment shall be truly circular in cross section; of the remainder, which are elliptical or oval, the difference between the length of the major and minor axis shall not exceed ⅜ inch. Pipe having cross sections, which exhibit angles, sharp curves or flat places, will be rejected. The pipe shall be made in lengths of 2, 2½ or 3 feet, as may be directed by the engineer, measuring from the bottom of the socket or hub to the spigot end; any material deficiency in said length shall cause the pipe to be rejected.

The thickness of each pipe shall be not less than 2 inches at any point, and the shell shall be of uniform thickness throughout, the outer and inner circumferences to be concentric. The hub or socket shall not be less than 4 inches in depth, and it shall not be less than 1⅜ inches in thickness. The hub shall be slightly converging towards its inner end or bottom.

All hubs or sockets must be of sufficient diameter to receive to their full depth the spigot end of the next following pipe, without chipping whatsoever of either, and also to leave a space of not less than ⅝ inch in width all around for the cement mortar joint: pipe that cannot be thus freely fitted together shall be rejected. Pipe showing indications that unsuitable or improper material has been used [illegible] shall be rejected. Pipe showing indications that it has not been thoroughly and properly vitrified or fused shall be rejected. A [illegible] pipe with pieces broken out of the socket or spigot ends [illegible] that is cracked from any cause [illegible] the thickness of [illegible] cracks shall be rejected. A [illegible] is more than [illegible] inch in [illegible]

[illegible] blisters on the inner surface of the pipe [illegible]

[illegible] shall be free from large blisters or flakes. [illegible] board of water commissioners [illegible] which may be either one of [illegible] dimensions of such pipe to be as specified. [illegible] awarded shall furnish all [illegible] equal in material and quality to the sample [illegible]

Bids were asked for furnishing the pipe in 2, 2½ and 3 foot lengths, the 3-foot lengths being preferred; this seemed advisable because of the necessary short time which could be allowed to fill the contract.

The contract for furnishing the pipe in lengths of three (3) feet was awarded to the Warner-Miller Co. of New Haven, the price being $1.19¾ per foot.

The pipe was made by the American Clay Manufacturing Company, three factories being employed in its manufacture.

Two inspections of the pipe were made, one at the time of unloading from the cars in Hartford, and again as the pipe was about to be laid in the trench.

Duplicate blank forms for each car load were furnished the inspector, which he filled in with the results of his inspection and returned to the engineer as each car was emptied.

The pipe line, traversing as it does the side of Talcott Mountain, is entirely through private property, mostly wood and pasture land, through which a right-of-way of 25 feet in width was secured.

The extremely rough and uneven condition of the hillside, together with the apparent large amount of solid rock to be encountered, necessitated the making of a topographical map of the proposed route, it having been decided that the minimum covering of the pipe should be three feet.

From this map was planned and laid out the line for the conduit as afterwards built.

To avoid as far as practicable sharp bends, and at the same time to shorten the line as much as possible, the conduit at several places is laid upon embankments built for the purpose. At one point the conduit intersects at right angles a valley through which passes a highway; to avoid a long detour into the valley, with several sharp bends and a large amount of rock excavation, the pipe at this point was, for a distance of 300 feet, dropped below the otherwise uniform grade maintained throughout the line, the lowest point in the depression being 9.65 feet below the established grade. Here the conduit is carried over a small stream, three lengths of cast iron pipe, supported on concrete piers, being used.

The alignment of the conduit is made up of arcs of circles and tangents; of the latter, the rolling nature of the ground allowed but few of any considerable length. It was possible to secure long radii for most of the curves, but a few were laid with radii about 175 feet in length.

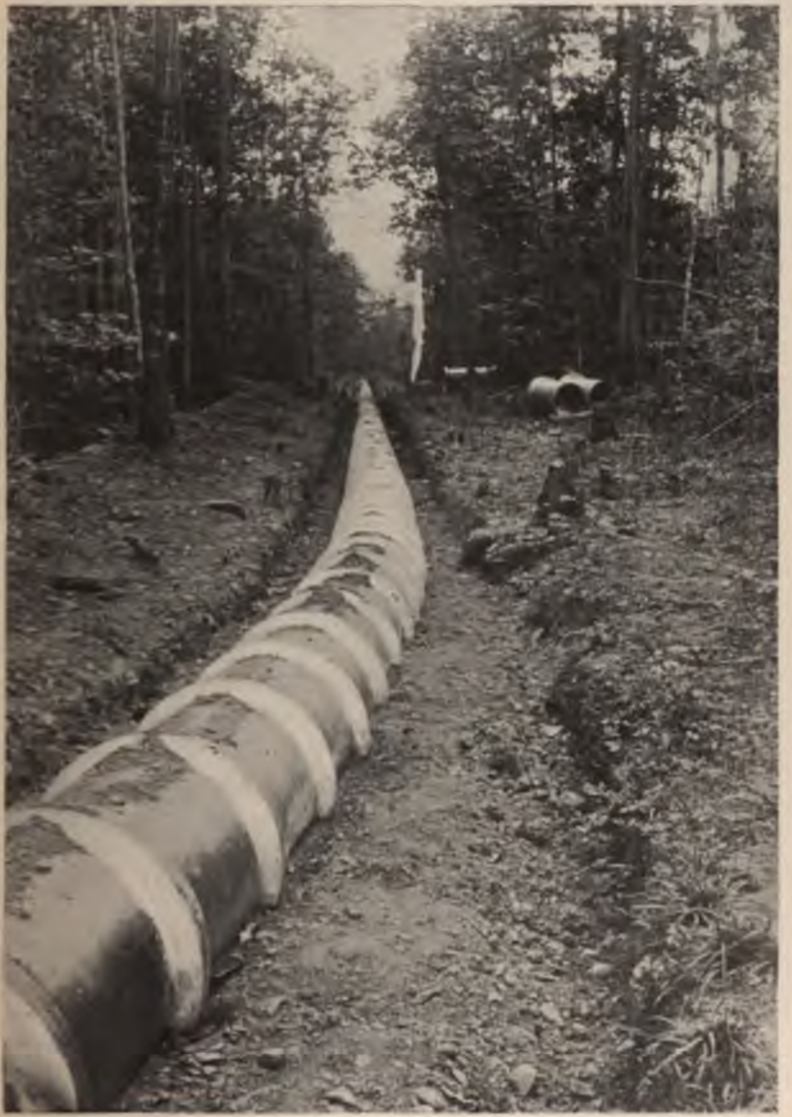
The trench had a bottom width of 4½ feet, no further excavation for bell holes at the sides of the trench being necessary.

The bottom of the trench was excavated, but without special care, slightly below the grade of the pipe; the grade and alignment for the pipe was obtained from a line of stakes driven in the bottom of the trench, one every 12½ feet.

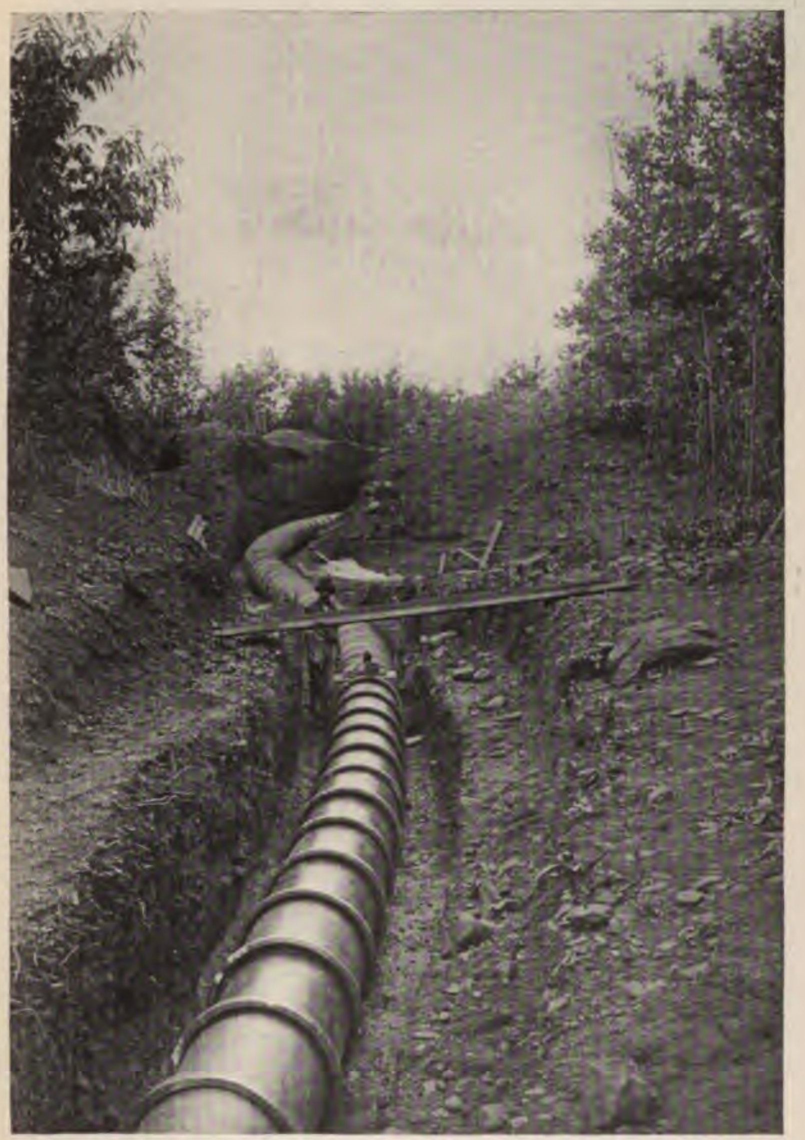
At intervals of three feet, spruce blocks 2x4x15 inches were thoroughly imbedded in the bottom of the trench, and at the same time the top of each brought to the required grade. This was accomplished by means of a cord stretched from one grade stake to the next; as the weight of each pipe was approximately 540 pounds, a light pipe derrick was used for lowering them to their position on the spruce blocks, the alignment between the grade stakes being trusted to the man in charge.

The pipe being placed in position its inner circumference was cemented with the preceding pipe and temporarily held in place by means of two hard wood wedges; the gasket having been cut into lengths sufficient to make one turn around the pipe, was worked back to the bottom of the bell in the usual manner, and the wedges removed. The outer surface of the spigot end and the inside of the socket were corrugated or furrowed, the object being to secure a larger amount of surface and consequently a better bond. The joints were filled with a mixture of equal parts of American Portland cement (Alpha brand) and clean sharp sand; as little water being used as possible. The cement was worked into the joints by means of rammers having a face 4 inches long and $\frac{5}{16}$ of an inch wide, and which were slightly curved to conform with the shape of the bell; the space at the ends of the bells being filled with cement, the finished surface forming approximately an angle of 45° with the surface of the pipe.

The back filling was deferred until the cement had thoroughly set and a final inspection of the joints had been made. All openings or unevenness at the joints on the inside of the conduit were



24-Inch Vitrified Clay Pipe Conduit Hartford Water Works.



24-Inch Vitrified Clay Pipe Conduit Hartford Water Works.

thoroughly filled with cement, thus securing one continuous smooth surface.

Special attention was paid to the back filling under and around the pipe, tamping bars similar to those used in track work being principally used; the filling being carried to the top of the pipe and all thoroughly rammed.

In this condition the trench was left until the completion of laying and the line put to its ultimate use.

At the foot of the slope at reservoir No. 6 a well was built, and with this the 20-inch pipe leading from the reservoir and the 24-inch pipe conduit were connected; the well is of concrete, 8 feet in diameter and 9 feet in depth, the connection between the well and the conduit being a 30-inch by 24-inch reducer.

The depth of the water in the well is controlled by means of a gate valve placed on the 20-inch pipe. The length and grade of the conduit being as given, its carrying capacity was calculated to be 8,600,000 gallons per day ($N=.012$), without running under a head. For a period of 30 days the drop in reservoir No. 6 and the rise in the lower reservoir were carefully noted, and other factors entering into the calculation considered. These figures would indicate that the conduit was discharging about nine and three-fourths million gallons per day. The work was done by the Water Board; the cost of the pipe line, not including excavation and back filling of trench, was $1.49¾ per foot.

REPORT OF COMMITTEE ON OFFICE MANAGEMENT.

In connection with the frequent gathering together of numerous kindred enterprises, and their concentration and organization into a great "Combination" or "Trust," we are constantly reminded by those actively engaged in promoting these aggregations of wealth and industry, that one of the most beneficial results, at least to the stockholder, is the reduction of operating expenses, due to the centralization of authority, and the adoption, throughout the various plants forming the "combine," of approved methods of production in the mill, and a uniform system of business procedure in the office.

When we occasionally come in touch with a part only of such a system, and view with impatience the apparently needless waste of time and energy in the careful recording of our transaction, in a way peculiar to the system used, we stigmatize the whole thing as "red tape" and are more than human if we refrain from offering numerous volunteer suggestions on how the other fellow should not run his business, with which we have but a bowing acquaintance.

A more intimate knowledge, of the management of any large business, removes all doubt as to the necessity of keeping by means of a recognized system, a complete record of its innumerable details, and the wonder grows, not that a system is necessary, but that any system can be devised so complete, and so elastic, that an accurate check is possible on the endless number of transactions, large and small, common to a growing business.

The coming together of a dozen or more small concerns makes the adoption of a uniform system absolutely necessary. Without it the result would be "confusion worse confounded."

When we have only mentioned the use of a system in its relation to a great and many sided proposition, it was with a view of bringing its advantages into stronger relief; for, while it is required in the management of large affairs, in the small office it is often put aside as cumbersome or unnecessary.

This may be true during the "waiting time" of the young professional man, who knows, by instinct, the exact location of each of the few commissions in the bundle under the table. It does not serve, however, when the accumulation of years makes the finding of any particular record largely a matter of chance, to say nothing of the disheartening task of looking for something which is not in the dozen and one places one expected to find it, and the too frequent report of that much abused worthy, the office boy, "I can't find it, sir."

While the majority of offices use a system, more or less complete, for the filing and indexing of drawings, records, etc., it is too often so unsystematic and imperfect that it proves worse than useless. It is then vain boasts are made, that the next rainy day will see wonderful changes wrought in the arrangement of the case or cupboard, but, like the shingling of the barn, it is only when records can't be found that the need of a system is manifest.

A method of filing and recording the various drawings, documents, etc., incidental to an engineer's office, should be simple, rational, capable of unlimited application and expansion, and involve as little clerical work as is consistent with an accurate and complete record and reference file.

Such a system is in operation in one of the largest offices represented in our Association, the City Engineer's office, of Hartford.

While no claim is made for its absolute perfection, it represents good points culled from the various systems used in offices visited throughout Massachusetts, Rhode Island and Connecticut, before the system was arranged and adopted in Hartford.

It would be impracticable, in the limits of this report, to fully cover all details of this system, and its application to the various branches of the office work. That the methods used may be better understood by those not familiar with such a system, we submit, in detail, their application to the every day work done in the office.

The adoption of a system in any office would necessitate a careful study of local conditions, and the character of the work done in the office.

This should be kept in mind in regard to the system to be described. While the methods used might be applied to any office, the arrangement of cases and files must, of necessity, depend upon the size and shape of the space available. In this office the two ends of the present fire-proof vault were utilized, and the space is rather cramped for the amount of work done in the office.

It is more convenient, when possible, to have a separate cabinet for each of the different sized drawings used, with a distinguishing group of numbers for each. Also separate drawers for drawings, tracings, and blue prints.

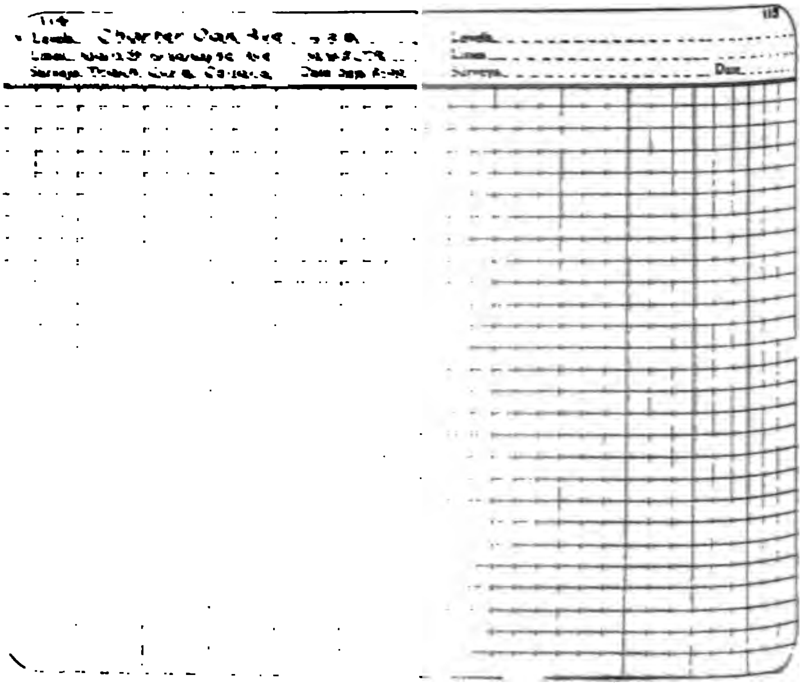
In the following description, so far as possible, a drawing will be followed through the office from its inception to the final operation of filing it away for reference.

The various operations of recording and filing will be mentioned consecutively as they naturally occur in the office practice. These will be easily understood by referring to the accompanying cuts, showing fac-similes of the record cards and books used.

Mention will also be made of a number of little "Knacks" which relate to the general office work and materials, as well as the system of recording and filing.

It may be well to describe first, the field note books, which are made to order and differ slightly from those usually supplied.

The following cut shows the ruling of the page and the headings.



Field Note Book.

The horizontal lines are in blue, the vertical lines in red. The pages of the note books are all ruled alike, as the book is used for both levels and surveys. It contains 135 pages, 5 inches × $7\frac{3}{8}$ inches in size, is bound in black leather, which does not show soil, and has plainly stamped in gold on the cover, the number of the book and

CITY ENGINEER'S OFFICE,
HARTFORD, CONN.

The book number is also stamped on the back, for filing on the shelf.

A running index is kept in the front of the book in which surveys are indexed as made; these are checked off when the work is finally indexed in the card case.

When in use in the field the note book is protected by a heavy paper cover which is removed when the book is filled and filed away. Note books are filed in an open compartment in the upper part of filing case.

The initials of the members of the party doing the field work will be noticed in the upper right hand corner of the cut. This record is for the purpose of placing responsibility in case of mistakes in this part of the work.

The case in the left end of the vault contains: Two complete card indexes, one for note book records and one for general work; compartments for the note books; and all the even numbered drawers, in which are filed all general drawings, except profiles.

Profiles are filed in the odd numbered drawers, in the opposite case, as will be described later.

Unfinished drawings are placed in a special drawer until completed.

A word of warning to those who have had no experience with a card indexing system. It is very necessary that the greatest care be exercised in properly classifying the work indexed. Whenever the title mentions more than one subject, or when additional data is contained on a plan or document, it should be cross indexed by filing a card under each heading. Many who have failed to observe this precaution have come to grief, and in language perhaps more forceful than elegant, concluded that an improperly indexed drawing, in a filing cabinet, was too much like the proverbial "needle in a hay stack."

To prevent a card, removed from the index, being misplaced, in returning to the cabinet, the street and heading under which it belongs should be written, in ink, on the back when the card is first filed.

The drawing paper used in the Hartford office, for all ordinary work, is cut from the dealers' standard sizes to the following sizes, with very little waste: 11x30, 22x30, 12½x40, 26x40, 14½x53, 30x35.

Drawers in case are arranged to hold 25 of the largest sheets and will hold a proportionately greater number as the sheets run smaller, up to 100 of the 11x30 size.

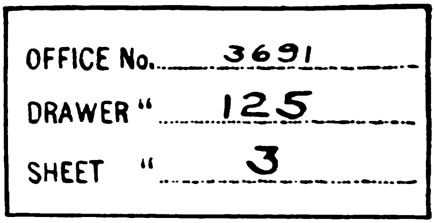
Triangular pieces of metal across the top of corners at the back of drawers prevent the drawings curling up, and swinging spring-clips answer the same purpose in front. Finger holes, in the bottom of the drawers, allow the drawings to be pushed up for easy removal.

Drawings are filed face down in the drawers. Where small sheets are filed in large drawers they are placed at the back of the drawers first, which brings the latest drawings near the front of the drawers for easy reference.

If the drawings are longer than 53 inches, they are rolled and filed in a large drawer provided in the case.

General drawings are all drawn to a scale of 40 feet to the inch. This is large enough for all ordinary work and is easily measured by contractors with a 2-foot rule.

After field notes have been made, the first step in the office work is the selection of a suitable size for the drawing, and a sheet of paper is selected accordingly. It is at once marked on the back with a rubber stamp, as follows:



OFFICE No. 3691
DRAWER " 125
SHEET " 3

And on the face, in the lower right hand corner, with this stamp:

CITY ENGINEER'S OFFICE,
HARTFORD, CONN.
SEWER & UNDERGROUND DEP'T.
Date Sep't 14-1900 Day Book No. 05921
Notes Vol 203 pp 114-127
C. H. Bunce City Engineer.

This done, record is made in the day book and proper numbers are found and indicated on the drawing.

The day book is an important part of this system, and will be seen from illustration to contain all necessary information in relation to the drawings.

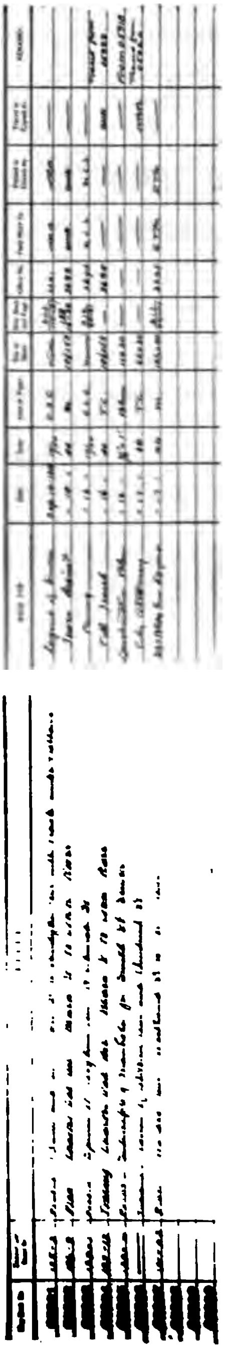
The upper part of a page, with headings, is shown by cut. Each page contains 40 numbers, and the book, open, is 17 inches wide, 28 inches long, and contains spaces for indexing 6,000 drawings. Day book numbers, at the extreme left of the book, are printed in red, and are preceded by 0. to avoid possible confusion with the office number, when indicated on cards or drawings.

In the front of the "Day Book" is an index numbered vertically on the left to correspond with the drawers of the various cases and cabinets, and horizontally, from 1 to the highest number of small sheets contained in a drawer (in this office 100).

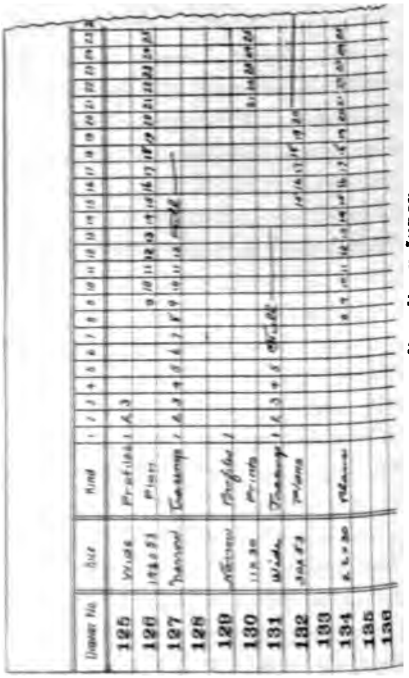
The drawers in the cases are assigned the various sized drawings and the dimensions of the same are indicated opposite the drawer number under the heading "Size." The material on which the drawing is made is specified under "Kind." When a sheet of a certain size and kind appears in this index, all similar sheets are placed in the same drawer until the capacity of the drawer is reached.

In the indexing and filing of a new drawing the "Day Book Index" is first used in the following manner:

If a sheet 30x53 is to be filed, a drawer for this size is assigned, and, as the same will hold but 25 large sheets, a red line is at once drawn through adjoining spaces in the index opposite the drawer



DAY BOOK.



PORTION OF DAY BOOK INDEX.

number, from 100 to 25, and the number 25 is brought down to the space horizontal to the size of the sheet indexed, and is at once written on the back of the drawing in the blank space adjoining "Sheet." Number of drawer, as indicated by the drawer number in the left hand column of the index, is also written in its space on the back of the drawing.

The next drawing of a similar "Kind" and "Size," would be indexed as No. 24, and so on, from right to left. By this method it is always possible to know, from the index, the capacity of the drawers and what space is left in any particular drawer.

The method of describing and indexing a drawing in the "Day Book" proper, will be readily understood from the accompanying cut.

Every drawing made in the office, or filed by local engineers, is indexed in the day book and the card file, and receives its proper day book number, but only such drawings as are placed on file in the office are given an "Office Number." This accounts for the difference between the "Day Book Number" and the "Office Number."

The total number of drawings made during any stated period is easily found by subtracting "Day Book" numbers opposite the dates in question. The total number of drawings on file is similarly found from "Office Numbers."

Drawings filed by local engineers for office record are indexed in the day book with red ink and filed and recorded in the card system in the same manner as work done in the office.

All profiles are filed in the odd numbered drawers contained in the case in the right end of the vault. This case also contains compartments for scrap books, large map books, etc.

Strawboard mailing tubes, somewhat shorter than the width of profiles, are provded, one for each profile.

Profiles are marked on the back, at each end, with the same stamp as for the general drawings, and the tube is also stamped to correspond.

Profiles are indexed in the Day Book and the card index, in the manner described for the general drawings, and the numbers when assigned are placed on tube and drawing.

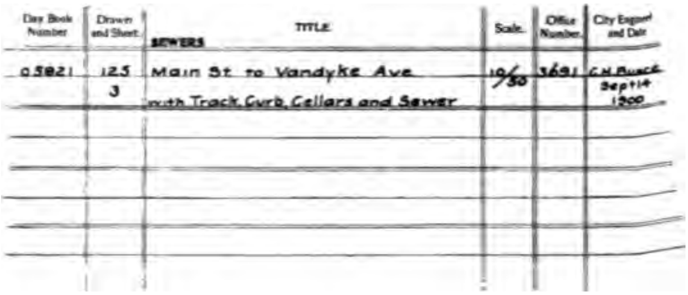
Drawers are six tubes in width and hold six long and twelve short profiles. When a profile is removed from a drawer the tube remains in its place.

Profiles are made on "Perfect" cross-section cloth, which is found to be in every way superior to paper.

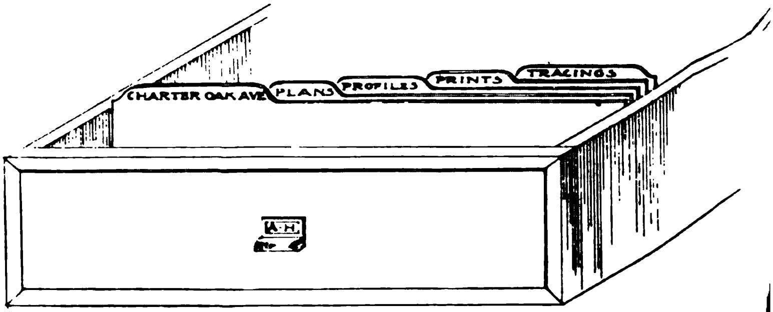
The system of card indexing is shown by the accompanying cuts.

Isometric views indicate the guide cards, and their arrangement in the drawer.

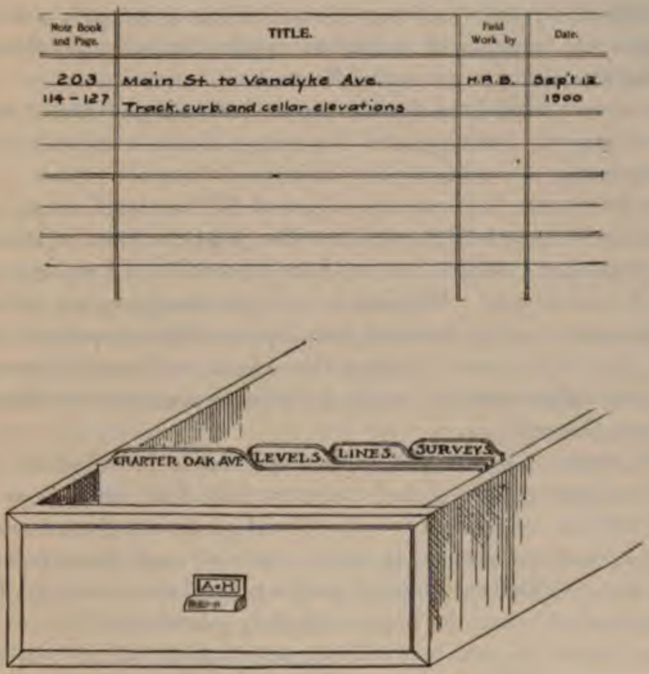
In this office colored cards are not used to indicate the various sub-headings. White cards are provided for the general index, each having a sub-heading printed in red under "Title." These headings are "Sewers," "Street and Building Lines" and "Miscellaneous." Guide cards in the general index are "Plans," "Profiles," "Prints," "Tracings." In the Note Book index, "Levels," "Lines," "Surveys."



Day Book Number	Drawer and Sheet	TITLE SEWERS	Scale.	Office Number.	City Engineer and Date
05821	125 3	Main St to Vandyke Ave with Track, Curb, Cellars and Sewer	10/50	3691	C.H.Buck Sept 14 1900



CARD AND INDEX FOR GENERAL DRAWINGS.



Note Book and Page.	TITLE.	Field Work by	Date.
203 114 – 127	Main St. to Vandyke Ave. Track, curb, and cellar elevations	H.R.B.	Sep't 12 1900

Field Note Index and Card.

When a card system was adopted in this office a large number of very old maps, seldom used, were filed in suitable drawers and indexed in the card system, for which purpose a blue card was used; this prevents possible confusion with current work.

The card index is found useful for the recording of data in relation to special work done in the office. At the present time a series of new bench marks are being established throughout the city; as rapidly as they are determined a pink card containing the information is indexed under the guide card "Levels," following the proper street card. When this work is completed the data will be published in pocket book form, for the convenience of local engineers, and the cards can, on account of color, be easily removed from the system.

The general form of the cards and their arrangement in the index is shown by the illustrations, and indicate a compact and ready reference file, capable of unlimited application in connection with the business of any engineer's office.

The system used here for the proper indicating of street, building and veranda lines suitable for easy reference, is both simple and efficient.

The entire city is covered by a set of 122 sectional maps, black prints on cloth, each 28 in.x38 in. The proper location of all buildings, street and veranda lines, and the ownership of property, is indicated in each case. Changes in lines or ownership are indicated as they occur, and in this way the maps are kept constantly up to date. On all lines are indicated the volume and page of the scrap book containing notice of original layout as passed by the Board of Common Council.

This makes a convenient and easily handled record of all property lines, building lines, and the ownership of all frontage as used in the various assessments of the Board of Street Commissioners.

A memorandum sheet is posted on the wall near the map case on which are indicated any changes pending in relation to lines. These are checked off when the line is definitely established.

These maps are not indexed in card system, but are shown by large scale map of the city hanging near case on which is indicated by means of various colors, the area covered by each sectional map. Each colored section has a distinguishing number which corresponds to the number of the accompanying map.

The much abused "Scrap Book" fills an important place in the every day work of this office, and can certainly become a most useful record in every office.

Special well bound books are provided, marked and numbered in a manner similar to the note book previously mentioned.

An alphabetical index is arranged in the front of book, and all clippings are carefully indexed under the various headings.

All notices published in the daily papers relating to the work of the Board of Street Commissioners are placed in these scrap books, and indexed as mentioned.

In relation to "Estimate of Amount Due" for work furnished the Board of Street Commissioners or Council, through the City

Engineer's office, a special blank is provided which assistant engineers fill out, showing work done under their supervision. These blanks are printed and filled out with copying ink, and are copied in a special copying book in a regular copying press.

Similar blanks are used showing a "Comparison of Bids" received on each contract. Spaces are provided for the names of the several contractors and amount of each bid, the "Sureties," for the lowest bidder, and the second lowest bidder, and the engineer's "Approximate Estimate of Quantities." These are copied and indexed in copying book with "Estimates."

This, in the main, constitutes the system of filing and recording work done in the office under consideration.

We have not attempted an exhaustive description of the methods used, but have endeavored to indicate the principal features of the system with sufficient detail to make their application to the various branches of office work clear to those who may be unfamiliar with the operation of such a system.

We also trust that the description may contain something of interest and value to those who already have in operation a system for the recording and filing of their work.

Respectfully submitted,

THEODORE IRVING COE,
FREDERICK P. LEWIS,
HENRY R. BUCK,
Committee on Office Management.

NOTE.—The committee wishes to acknowledge the courtesy and co-operation of City Engineer C. H. Bunce and the Assistant Engineers for assistance rendered in the preparation of this report.

LIST OF MEMBERS.

With Addresses and Dates of Election.

Members are particularly requested to keep the Secretary constantly informed as to their correct addresses.

HONORARY MEMBERS.

JOHN E. CLARKE......April, 1884
Prof. Mathematics at Sheffield Scientific School of Yale University,
New Haven, Conn.

DESMOND FITZ GERALD......Jan. [illegible] 1901
Engineer Sudbury Division, Metropolitan Water Board,
1 Ashburton Place, Boston, Mass.

GEORGE H. FROST......April, 1884
Prest. Engineering News Publishing Co., New York.

EDWARD C. HAYNES......Jan. 24 [illegible]
Centre Lebanon, Maine.

WILLIAM E. PETTEE......Jan. [illegible] [illegible]
Civil Engineer, Lakeville, Conn.

FRANK W. SKINNER......Jan. [illegible] [illegible]
Editorial Staff of the Engineering Record, New York.

ROBERT R. SMITH......June [illegible] [illegible]
City Engineer, New Hartford, Conn.

EDWARD S. WATERS......Jan. [illegible] [illegible]
Chief Engineer Holyoke Water Power Co., Holyoke, Mass.

ACTIVE MEMBERS.

ARTHUR A. ADAMS......Jan. [illegible] [illegible]
Supt. of Streets, Springfield, Mass.

[illegible] ADAMS......July [illegible] [illegible]
Chief Engineer Hartford, Manchester and Rockville Tramway Co.,
South Manchester, Conn.

[illegible]......Jan. [illegible] [illegible]
City Engineer, West Hartford, Conn.

[illegible] ATKINS......Jan. [illegible] [illegible]
Civil Engineer and Surveyor, [illegible], Conn.

[illegible]......April, 1884
Civil Engineer and Surveyor, Middletown, Conn.

[illegible]......Jan. [illegible] [illegible]
[illegible] Engineer, Hartford, Conn.

[illegible]......Jan. [illegible]
Civil Engineer, [illegible], Conn.

SAMUEL E. BARNEY.......... Jan. 9, 1900
Prof. Civil Engineering Sheffield Scientific School, New Haven, Conn.

CHARLES EDWARD BEACH.......... Jan. 10, 1893
Civil Engineer, West Hartford, Conn.

EDGAR T. BELDEN.......... Jan. 8, 1901
66 Maiden Lane, New York City.

CLIFFORD H. BELDEN.......... March 30, 1900
Civil Engineer, Hartford, Conn.

HORACE E. BENNETT.......... Jan. 8, 1901
Water Dept., Hartford, Conn.

RAYMOND F. BENNETT.......... March 30, 1900
W. F. Bennett & Son, Contractors, Portland, Maine.

RICHARD M. BERRIAN.......... Jan. 9, 1900
Engineering Department, N. Y., N. H. & H. R. R. Co.,
Bridgeport, Conn.

GEORGE H. BISHOP.......... Jan. 13, 1885
Hydraulic Engineer, Middletown, Conn.

CLARENCE BLAKESLEE.......... Jan. 9, 1900
Civil Engineer and Contractor, New Haven, Conn.

GEORGE L. BLAKESLEE.......... Jan. 8, 1901
Assistant Engineer, Wigwam Reservoir, Waterbury, Conn.

JAMES P. BOGART.......... Jan. 9, 1900
Civil Engineer, New Haven, Conn.

DANIEL E. BRADLEY.......... Jan. 9, 1894
President Berlin Construction Co., Berlin, Conn.

THOMAS N. BRADSHAW.......... Jan. 8, 1901
Cable Foreman S. N. E. Tel. Co., New Haven, Conn.

D. S. BRINSMADE.......... April, 1884
Engineer Housatonic Water Power Co., Derby, Conn.

CHARLES O. BROWN.......... Jan. 11, 1898
Civil Engineer and Surveyor, Danbury, Conn.

EDMUND BROWN.......... Jan. 10, 1899
Supt. and Engineer of Norfolk Water Co., Norfolk, Conn.

HENRY R. BUCK.......... Jan. 10, 1899
City Engineer's Office, Hartford, Conn.

JOHN E. BUDDINGTON.......... March 30, 1900
Consulting Engineer and Contractor, New Haven, Conn.

CHARLES H. BUNCE.......... April, 1884
City Engineer, Hartford, Conn.

LUTHER W. BURT.......... Jan. 13, 1885
Civil Engineer and Surveyor, Hartford, Conn.

LUTHER HAROLD BURT.......... Aug. 14, 1900
Office of Division Engineer, Lehigh Valley R. R., Easton, Pa.

EDWARD W. BUSH.......... Jan. 10, 1899
Assistant Engineer Conn. River Bridge and Highway District.
Hartford, Conn.

WILLIAM E. BUSH.......... Jan. 8, 1901
City Engineer's Office, New Haven, Conn.

EMIL CHARLES BUSCHOR.......... Jan. 10, 1893
Civil Engineer and Surveyor, Central Valley, New York.

WILLIAM H. CADWELL..May 31, 1893
Civil Engineer, New Britain, Conn.

ALEXANDER CAHN..Jan. 9, 1900
Civil Engineer, New Haven, Conn.

ROBERT A. CAIRNS...Aug 29, 1890
Sanitary and Hydraulic Engineer and City Engineer, Waterbury, Conn.

HUBER D. CARD..Oct. 24, 1895
Civil Engineer and Surveyor, Willimantic, Conn.

HARRY E. CARLISLE..Jan. 9, 1900
Engineer S. N. E. Telephone Co., New Haven, Conn.

RALPH B. CARTER...Jan. 14, 1890
Civil Engineer, 35 Dey St., New York.

FRANK CAUM...Aug. 14, 1900
Supt. Hartford Street Railway, Hartford, Conn.

CHARLES F. CHASE..March 30, 1900
Engineer Berlin Construction Co., New Britain, Conn.

CHARLES E. CHANDLER...April, 1884
Civil Engineer, Norwich, Conn.

RICHARD OTIS CHENEY, JR...................................Jan. 9, 1900
Civil Engineer, South Manchester, Conn.

CLARENCE H. CLARK...March 30, 1900
Draughtsman N. Y., N. H. & H. R. R., New Haven, Conn.

EDGAR CLARK...June, 1887
Civil Engineer and Surveyor, Putnam, Conn.

HERBERT G. CLARK...July 18, 1899
Engineer of Keney Park, Hartford, Conn.

ROSCOE N. CLARK..July 18, 1899
Civil Engineer Dept. of Public Parks, Hartford, Conn.

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City Engineer, Meriden, Conn.

WILLIAM B. COCHRANE...Jan. 14, 1890
Civil Engineer, Stamford, Conn.

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Supt. of Construction with Isaac Allen, Architect, Hartford, Conn.

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Supt. of Water Works, New Bedford, Mass.

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Collins & Norton, Engineers and Contractors, Springfield, Mass.

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Civil Engineer and Surveyor, New London, Conn.

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Secretary Hartford Paving and Construction Co., Hartford, Conn.

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General Manager Hartford Street Railway Co., Hartford, Conn.

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Vice President N. Y., N. H. & H. R. R., Boston, Mass.

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Curtis & Johnson, Hartford, Conn.

LOREN E. DABOLL..Jan. 8, 1895
City Surveyor, New London, Conn.

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With William G. Smith, Waterbury, Conn.

HENRY L. DAVIS...Jan. 14, 1890
Civil Engineer, Wallingford, Conn.

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Assistant Manager Eastern District and Export, American Bridge Co., 100 Broadway, New York.

FREDERICK DE PEYSTER...Sept. 3, 1891
General Manager of the Brainerd, Shaler and Hall Quarry Co., Portland, Conn.

SOLOMON LE F. DEYO...Jan. 9, 1900
Chief Engineer New York Rapid Transit Subway Construction Co., New York City, N. Y.

AUGUSTUS J. DU BOIS...Jan. 9, 1900
Prof. Civil Engineering Sheffield Scientific School of Yale University, New Haven, Conn.

FREDERICK J. EASTERBROOK..................................March 30, 1900
Asst. Engineer N. Y., N. H. & H. R. R., New Haven, Conn.

CHARLES W. EDDY..Jan. 9, 1900
Assistant Engineer Wigwam Reservoir, Thomaston, Conn.

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With American Bridge Co., 7 West 22d St., New York.

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Div. Engineer N. Y., N. H. & H. R. R., New Haven, Conn.

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Chief Engineer Central New England Railway, Hartford, Conn.

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Civil Engineer and Surveyor, New Haven, Conn.

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Local Manager S. N. E. Telephone Co., Hartford, Conn.

FREDERICK L. FORD...Jan. 12, 1897
Assistant City Engineer, Hartford, Conn.

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City Engineer's Office, New Haven, Conn.

EDWARD GAGEL..Jan. 9, 1900
Division Engineer N. Y., N. H. & H. R. R., West Haven, Conn.

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City Engineer's Office, Hartford, Conn.

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City Engineer's Office, New Haven, Conn.

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Assistant City Engineer, New Haven, Conn.

EDWARD O. GOSS..Nov. 29, 1890
Assistant Treasurer Scovil Mfg. Co., Waterbury, Conn.

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Chief Engineer Conn. River Bridge and Highway District, Hartford, Conn.

A. CLARK HALL.......................Jan. 8, 1901
Transitman Hartford Water Dept., West Hartford, Conn.

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City Engineer, Ansonia, Conn.

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With N. Y., N. H. & H. R. R., Hartford, Conn.

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Stamford, Conn.

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Supt. Electrical Department, N. Y., N. H. & H. R. R., Bridgeport, Conn.

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Draftsman Conn. River Bridge and Highway District, Hartford, Conn.

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Civil and Consulting Engineer, New Haven, Conn.

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Civil Engineer Highway Commissioner's Office, Hartford, Conn.

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Civil and Hydraulic Engineer, Bridgeport, Conn.

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First Assistant City Engineer, New Haven, Conn.

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City Engineer, New Haven, Conn.

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Civil Engineer, Port Chester, N. Y.

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Constructing Engineer of the Continental Compressed Air Co., Norwich, Conn.

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With Hartford Street Railway Co., Hartford, Conn.

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Superintendent Hartford Electric Light Co., Hartford, Conn.

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Major Engineers, U. S. Government, New London, Conn.

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Secretary Blake & Johnson, Waterbury, Conn.

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Assistant, General Superintendent S. N. E. Tel. Co., New Haven, Conn.

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Civil Engineer and Contractor, Springfield, Mass.

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Civil Engineer and Surveyor, Hartford, Conn.

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Civil Engineer and Surveyor, Hartford, Conn.

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City Engineer's Office, New Haven, Conn.

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Civil Engineer, New London, Conn.

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Instructor Sheffield Scientific School, New Haven, Conn.

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Sanitary and Hydraulic Engineer, Southington, Conn.

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Civil Engineer and Surveyor, Yalesville, Conn.

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City Engineer, Rockville. Residence, Ellington, Conn.

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Civil Engineer, Greenwich, Conn.

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Pres. and Engineer Conn. Patent Water Pipe Co., New Haven, Conn.

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Land Surveyor, Waterbury, Conn.

ARTHUR W RICE...April, 1884
Prest. Union Mfg. Co., New Britain, Conn.

WALTER H. RICHARDS..March 30, 1900
Engineer of Water and Sewer Departments, New London, Conn.

WM. LISPENARD ROBB..Jan. 9, 1900
Prof. of Physics Trinity College and Consulting Engineer Hartford Electric Light Co., Hartford, Conn.

ALBERT G. ROBINSON..Jan. 11, 1898
Civil Engineer and Surveyor, Patten, Maine.

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Architect (Crosby & Rogers), Hartford, Conn.

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General Manager Hartford Electric Light Co., Hartford, Conn.

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City Engineer's Office, New Haven, Conn.

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Civil Engineer and Surveyor, New Haven, Conn.

ALPH J. SABIN..April, 1884
Civil Engineer and Surveyor, Pomfret, Conn.

EORGE H. SAGE..Jan. 8, 1895
Vice President Berlin Construction Co., Berlin, Conn.

UGO SCHAEFER..March 30, 1900
Master Mechanic Central New England R. R., Hartford, Conn.

. HILLIARD SMITH..March 30, 1900
Architect, Hartford, Conn.

ILLIAM G. SMITH..April, 1884
Civil Engineer and Surveyor, Waterbury, Conn.

ARRY B. SNELL..Jan. 8, 1901
With Hartford Street Railway Co., Hartford, Conn.

HOMAS C. B. SNELL..July 18, 1899
Engineer Hartford Street Railway Co., Hartford, Conn.

ENRY SOUTHER..Jan. 10, 1899
Consulting Engineer, Hartford, Conn.

LBERT F. SPENCER..April, 1884
Civil Engineer and Surveyor, Bridgeport, Conn.

ORMAN C. SPENCER..Jan. 8, 1901
Asst. in City Engineer's Office, Hartford, Conn.

ALTER T. SPENCER..Jan. 9, 1900
Division Engineer, N. Y., N. H. & H. R. R., New Haven, Conn.

. WILLIAM SPERRY..Jan. 9, 1900
Civil Engineer and Surveyor, New Haven, Conn.

ILLIAM F. STEFFENS..March 30, 1900
Bridge Department N. Y., N. H. & H. R. R., New Haven, Conn.

AYMOND FRENCH STODDARD..Jan. 9, 1900
Civil Engineer with N. Y., N. H. & H. R. R., Milford, Conn.

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With H. A. Wolcott, Hartford, Conn.

ARRY A. STORRS..July 18, 1899
U. S. Asst. Engineer, New London, Conn.

UGH B. TABOR..Jan. 10, 1899
With E. P. Augur, Middletown, Conn.

UCIAN A. TAYLOR..June, 1887
Civil Engineer and Contractor, Boston, Mass.

EDWARD C. TERRY..March 30, 1900
Civil Engineer, Hartford, Conn.

AMES B. THOMAS..Jan. 9, 1900
Civil Engineer and Surveyor, Hartford, Conn.

OHN C. TRACY..Jan. 9, 1900
Instructor in Civil Engineering, Yale University, New Haven, Conn.

WALTER E. TRUESDELL..June 11, 1898
Engineer in charge of Construction with Tower & Wallace, New York City.

MAX J. UNKELBACH..Jan. 9, 1900
With W. H. Cadwell, New Britain, Conn.

CLARENCE B. VORCE..Jan. 10, 1899
Civil and Consulting Engineer, Hartford, Conn.

A. R. WADSWORTH..Oct. 27, 1886
Civil Engineer and Surveyor, Farmington, Conn.

EDWARD T. WARD...Jan. 9, 1900
Consulting Engineer, Bridgeport, Conn.

ALBERT L. WASHBURN...Jan. 10, 1899
City Engineer's Office, Hartford, Conn.

HALSEY A. WEAVER..Jan. 12, 1897
Civil Engineer and Surveyor, Woodstock, Conn.

NELSON J. WELTON..April, 1884
Civil and Hydraulic Engineer, Waterbury, Conn.

CHAS. A. WHEELER...Jan. 8, 1901
Prof. of Mathematics, Conn. Agricultural College, Storrs, Conn.

JOEL M. WHEELER..June, 1887
Civil Engineer and Surveyor, Ansonia, Conn.

ELI WHITNEY...March 30, 1900
President New Haven Water Co., New Haven, Conn.

GEORGE E. WHITNEY...March 30, 1900
Superintendent Stamford Water Co., Stamford, Conn.

ERNEST W. WIGGIN...March 30, 1900
Second Asst. Bridge Engineer N. Y., N. H. & H. R. R., New Haven, Conn.

RALPH M. WILCOX..Jan. 8, 1901
City Engineer, Middletown, Conn.

J. K. WILKES..April, 1884
Civil Engineer, New Rochelle, New York.

THEODORE WIRTH..July 18, 1899
Supt. Public Parks, Hartford, Conn.

HENRY A. WOLCOTT...July 18, 1899
Mechanical and Civil Engineer, Hartford, Conn.

CHAS. N. WOOD..Aug. 14, 1900
Civil Engineer, Norwalk, Conn.

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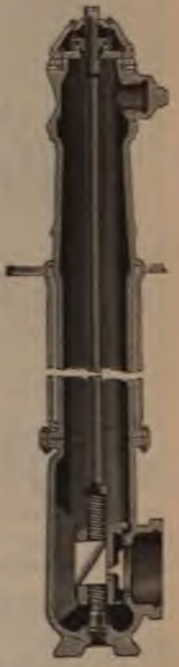

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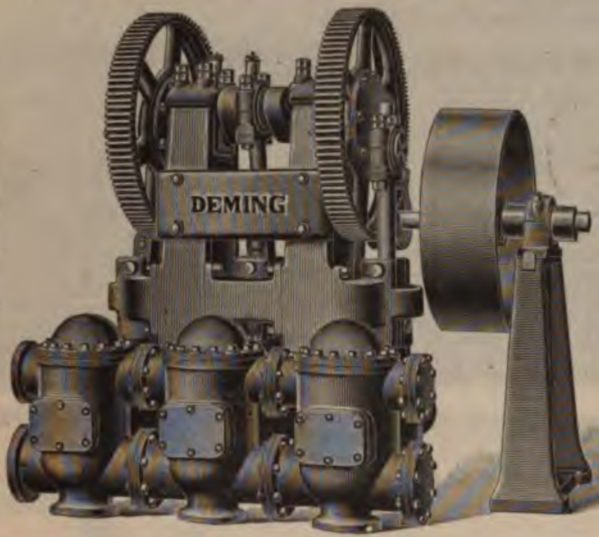

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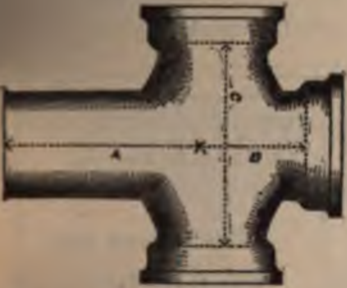

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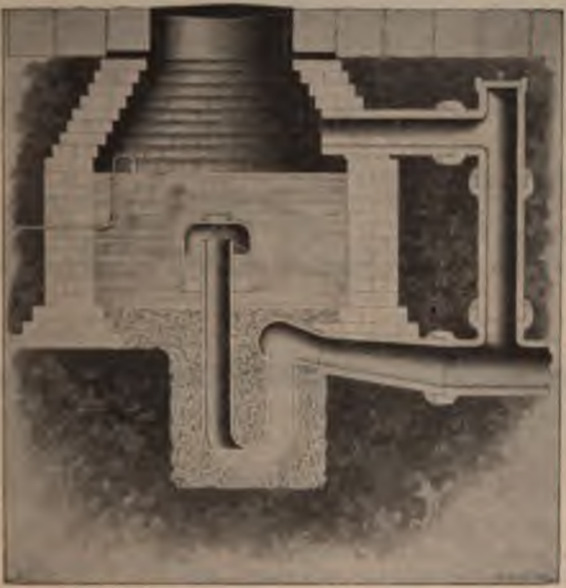

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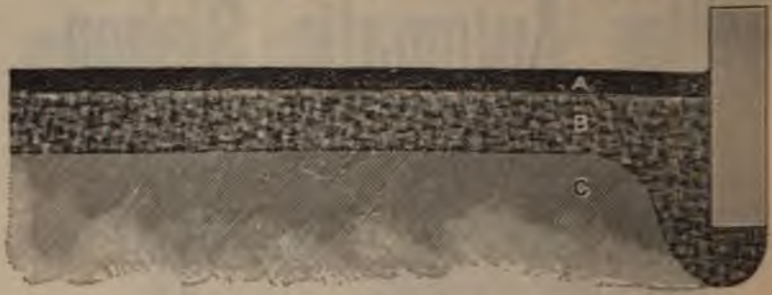

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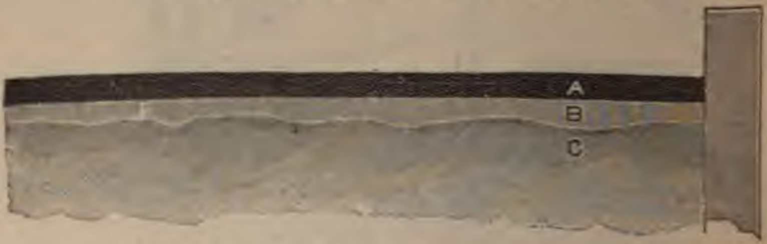

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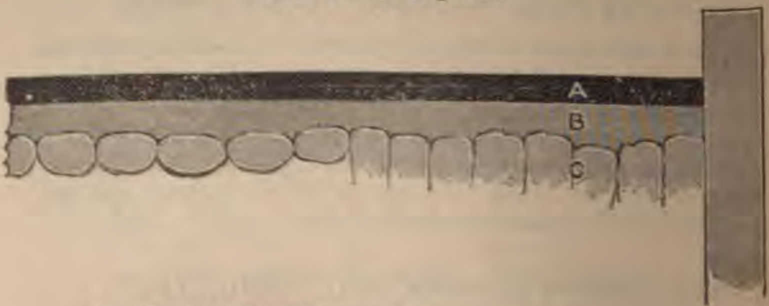

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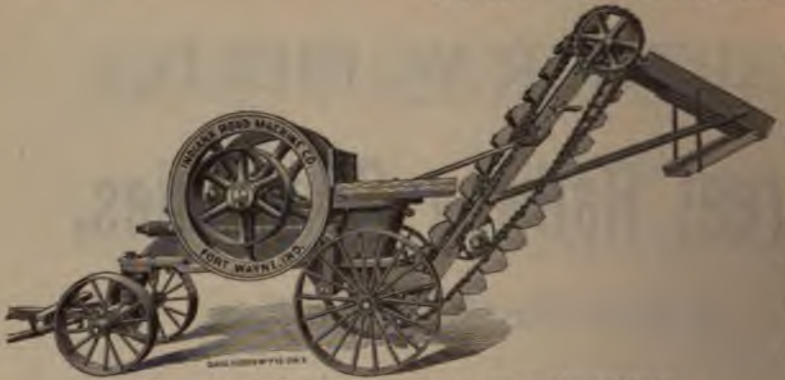
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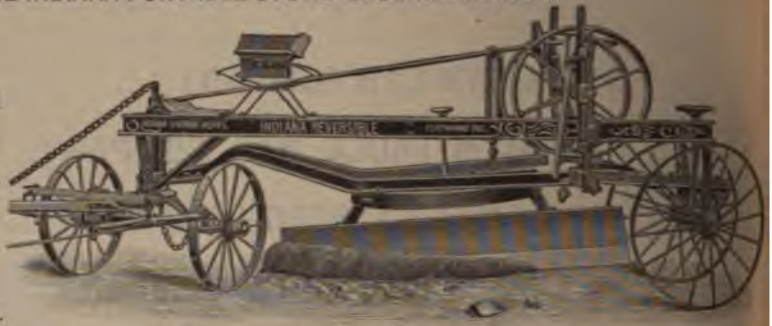

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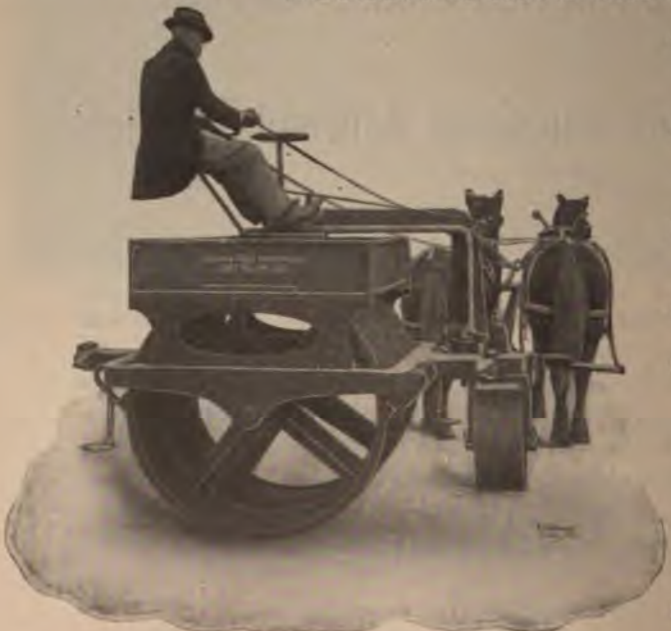

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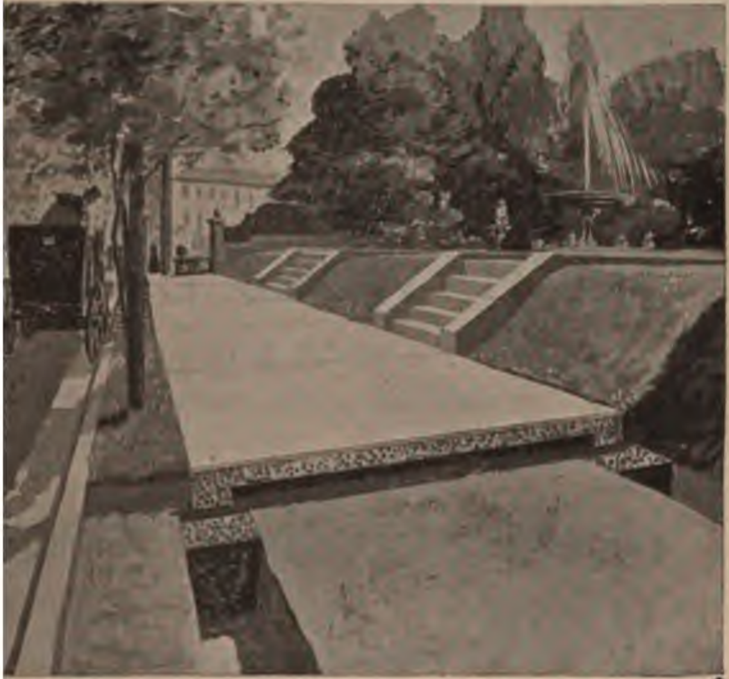

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Dr. Arthur T. Hadley.

Connecticut Society of Civil Engineers

* * *

PROCEEDINGS OF THE SPRING
MEETING HELD AT NEW
HAVEN, CONN., APRIL 20, 1901;
SUMMER MEETING, NEW LONDON AND NORWICH, AUGUST
22, 1901; AND ITS EIGHTEENTH
ANNUAL MEETING AT HARTFORD, FEBRUARY 11, 1902

* * *

New Haven
THE TUTTLE, MOREHOUSE & TAYLOR COMPANY
1902

Connecticut Society of Civil Engineers

ORGANIZED AT BRIDGEPORT, JANUARY 15, 1884

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WITH DATES OF SERVICE.

B. Hull	1884, 1885
Charles M. Jarvis	1886
Charles E. Chandler	1887
Charles H. Bunce	1888, 1889
F. Floyd Weld	1890
E. P. Augur	1891, 1892, 1893, 1894
Wm. G. Smith	1895, 1896
Robert A. Cairns	1897, 1898
Edwin D. Graves	1899, 1900
Henry J. Kellogg	1901

PROCEEDINGS

OF THE

Connecticut Society of Civil Engineers

AT THE

Spring Meeting Held at North Sheffield Hall,

New Haven, April 20th, 1901.

Convention called to order at 10.05 A. M., President Henry J. Kellogg in the chair.

Reading of minutes of last meeting omitted.

SECRETARY CRANDALL: No report at this time.

Some of the members of the Committee on Membership being absent, President Kellogg appointed Mr. Ford, Mr. Tracy and Mr. Daboll to consider applications for membership.

The consideration of the new constitution was postponed until afternoon.

THE PRESIDENT: As soon as the Membership Committee reports, I will wait upon President Hadley, and we will open the exercises of the day with his address.

The Committee on Membership submitted the following report:

"Your committee, to whom was referred the list of applications for membership, have examined them all carefully, and they recommend action be taken on the applications in the following manner: that George D. Foote and Francis G. Daniell be elected as Associate members. That Dr. Arthur T. Hadley, President of Yale University, and Prof. Russell H. Chittenden of the Sheffield Scientific School, be elected as Honorary members, and Daniel Brinsmade, Frank E. Hine, Samuel G. Stoddard, Jr., Henry DeB. Forbes, Theodore B. Ford, George A. Lund, Dennis J. Maloney, Ernest B. Moss, and Frank P. Johnson be recommended as Active members. The committee would suggest that they be balloted on first, and if there is any objection to any of them that they be acted on separately."

THE SECRETARY: I move that the report of the Membership Committee be accepted, and that the applicants be elected as reported.

Motion seconded and passed.

The following communication was received from the Engineers' Society of Western New York, relative to visiting engineers to Pan-American Exposition:

975 ELLICOTT SQUARE,
BUFFALO, N. Y., March 12, 1901.

The Pan-American Exposition, to be held in this city the present year, will offer much of interest to Engineers. We regret that the plan proposed for a separate engineering exhibit has been found impracticable.

The Engineers' Society of Western New York desires to extend to visiting engineers every possible courtesy. Its rooms are most centrally located in the Ellicott Square. The headquarters of the Exposition, telegraph office, telephone station, restaurant, etc., are in the building.

During the Exposition our rooms will be open during the day, and we extend a most cordial invitation to the members of your Society and all visiting Engineers to make use of them while in Buffalo. Your mail addressed care of "Engineers' Society of Western New York, No. 975 Ellicott Square," will be cared for and information gladly furnished regarding the Exposition and other points of interest to Engineers in the city and vicinity.

A stenographer will be in attendance, whose services may be procured by visiting engineers.

Meetings of the Society are held the first Tuesday in each month, at which all visiting engineers will be most heartily welcomed.

Yours respectfully,
WILLIAM A. HAVEN, *President.*
G. C. DIEHL, *Secretary.*

By motion it was voted that the Secretary be instructed to tender the thanks of the Association for above invitation.

By motion it was voted, that the above address, and such directions as are necessary to enable the members to take advantag of the invitation, be printed in the minutes of the meeting.

The President announced that dinner would be served at the Tontine Hotel at 2 P. M., and that at the close of the morning session the members were invited to visit the power station of the Fair Haven & Westville R. R. Co.

Recess.

President Kellogg called meeting to order and introduced President Hadley, who spoke as follows:

Mr. President and Gentlemen:—

It is, I assure you, the greatest pleasure to be present at a gathering like this, and to have the opportunity of welcoming you to Yale University.

It has been well said that this is an age of consolidation. In all the material departments of life, whether commercial or industrial, we are realizing the economy which arises from putting together things which were formerly separate. But in matters educational, we have not progressed so far, nor secured the gain which follows from such consolidation. We still think of life as something divided into separate parts. We still regard the period of education as one such part, and the period of practical work as another and separate one. During the former period a student learns many things which have relatively little subsequent use to him; during the latter period he wastes, in getting started in his profession, much time and strength which might be employed serviceably to himself and to the community. It is hardly necessary to say that this involves a tremendous loss; and the loss often falls heaviest upon the best men, because they frequently are the ones who find it hardest to spare the time and the money involved in this period of unnecessary waiting. How, then, can we avoid this loss? How can we lengthen the period of training which modern expert work demands without postponing the years of real professional success until a time so late in life that even the rich man feels the delay as a burden, and the poor man cannot afford it at all? Only by doing away with this unnatural separation. Only by bringing the work of the later days of student life into such intimate connection with that of the early days of professional life that the student shall be training himself in what is wanted, and that the office shall be able to find at the same time what men it needs for its expert work, and utilize their services promptly. But for this end we must have a far freer interchange of thought between the universities and the practical men of the country than has hitherto been possible. If the universities can know from the offices and the shops of the country more exactly the kind of men they want and the kind of training they want, the students can, during the later years of their course, be far more satisfactorily prepared for the problems with which they have to grapple; and on the other hand, if the offices and shops can know from the universities what kind of men they are training, they can in turn be far surer of finding the right kind of experts instead of the wrong kind of experts for filling the positions in which scientific knowledge is valuable.

In this respect we stand far behind some other countries, particularly those of continental Europe. In Germany and in France, university training is specifically adapted to the needs of those who are to go out into practical life. The problem is easier to solve in Germany and in France than it is in the United States, because so many of these practical positions are government positions, for which a certain definite and specified training is wanted. The problem with which we have to deal in America is hard, because the habit of private enterprise instead of government control calls for greater variety of talent and training; and the universities, to meet the demands of private enterprise, would have to have their eyes open in a great many directions instead of a few only. But we ought not to shrink from the solution of a problem because it is exceptionally difficult. We have mastered correspondingly difficult problems on the material side of engineering work and other applications of modern science. Let us see if we cannot take hold of the social side of these problems. We have made more kinds of machines and more kinds of bridges, that do their work well and economically; let us see if we cannot be correspondingly successful in making more kinds of men. This is the problem which faces us at the present day,—the problem in whose solution university men and practical men are equally interested.

I have only stated this problem: I have not solved it. I wish very much that it were possible to see the solution as clearly as it is possible to see the problem. But we must be content to take one step at a time. If we can face squarely the conditions which are before us, we may be sure that the joint efforts of men, working to meet the difficulty from different directions, will, in the next twenty-five years, make rapid progress toward meeting them. Certain it is, that the closer we can get together and the more fully we can interchange ideas with one another, the more quickly we shall come to the solution of this problem. It is for this reason, more than for every other, that I welcome a meeting of the Association in this room. It means that we shall become better acquainted personally. It also means that we shall become better acquainted collectively; and that, in solving the educational problems of the future, we shall work not as isolated individuals, but as corporate bodies—nay, as one vast corporate body, having a common purpose and a common interest. I hope that this meeting will be in every way pleasant and profitable; that it will prompt you to come here again as often as possible; and that it will enable us all to coöperate with one another in the solution of those problems which neither the engineers alone nor the university alone is fully competent to deal with, but which are large enough to require the joint efforts of all who understand the conditions with which we are dealing. (Applause.)

THE SECRETARY: Mr. President, I move that the Association extend a vote of thanks to President Hadley for his very pleasant address of welcome.

Motion seconded and passed.

THE PRESIDENT: It has been suggested that the vote be made a standing one. All in favor will please rise. It is a unanimous vote.

Allow me to advise you, President Hadley, that you are elected an Honorary member of this Association. We are very proud to have you on our roll.

DR. HADLEY: I thank you very much, Mr. President and gentlemen, for your collective as well as individual coöperation in this matter.

A short recess was declared, that the members might meet President Hadley.

Meeting called to order.

Mr. Watson of the New York Expanded Metal Co., having been introduced by President Kellogg, spoke as follows:

Mr. President and Gentlemen:—

I want to thank you, each and all, cordially for this invitation to come before you. I am free to say, however, that the announcement that I am to lecture is a misnomer. I am in no sense a lecturer, except in private. I talk shop usually to a business man when I can catch him, and I am greatly obliged to you for this opportunity of speaking to an audience of more than the usual number. It is an unusual privilege, and one for which the industry which I represent should be exceedingly grateful as a recognition of its having reached that stage where it is something more than simply a business. It has come to be almost a profession.

What I shall say will not be of a technical order at all. I represent the business side of the enterprise. Mr. Bailey will describe that feature of the work which has been accomplished. I want to say a word concerning expanded metal, from what it grew, or began, to what it is to-day as an industry in the world. The inventor of it was the editor of an industrial journal in Chicago sixteen or eighteen years ago. Barbed wire in those days was selling at [illegible] cents per pound. It was expensive to build a barbed wire fence at that time, and he conceived the idea that some improvement might be accomplished by making the fence from sheet metal instead of from strands of metal. With that idea he cut pieces of paper into slits as they do in schools sometimes, and he found that it opened up in mesh form when the slits were made regular, and he immediately said he was going [illegible] the universe. He was, like most inventors, very [illegible]. He started out to make this fencing [illegible] and he spent four years with mechanical engineers, and several years before he produced a single square foot of material to sell. Up to that time his whole idea had been to make a fence, and he succeeded in making a machine for that purpose, but with some imperfections. The first business of the company, therefore, was to manufacture this fencing material, grates, rails, etc., and for three or four years after he succeeded in getting a practically perfect machine that was the exclusive business of the company. Then the idea was evolved that with smaller meshes the same material might be used as a substitute for wood lathes. It found but little reception at the hands of the trade, however. The cost was too high. After a year or so the process developed so that they were able to make it a little cheaper, and it was gradually reduced to almost the present prices of to-day. Thus was the industry started. Mr. Golden, the inventor, finally took the patents to Europe, and started a company in London. While in Europe he met what is known as a system of concrete construction, and that put an idea into his head, and he came back and adapted expanded metal to be used in connection with concrete. It was first used in flooring, and then in the successive forms in which it will be shown to you to-day. Our principal industry, therefore, has grown to twelve companies in this country, five of which are manufacturing, and the remainder are either mercantile or construction companies. The uses to which expanded metal is put in connection with concrete are now very varied. The earliest established system of a steel frame-work with concrete was in 1880, by Monier, in Europe. In 1884, in Hungary, a Mr. Wunsch adopted a system. Monier's system was simply an interlacing of the rods in basket form, or by simply laying them over each other at right angles, thus putting a tensile element into the construction, where otherwise it was non-tensile. Wunsch did the same thing with different forms of metal, using what might be termed structural shafts. In 1889 this system was brought to this country, the method being practically the same except that the iron was twisted into spiral shape, thereby enabling it the better to hold the concrete in place. That system has been used very successfully throughout the United States, and also in Europe; one form of it being especially adapted to bridge construction. In 1892 the first use of expanded metal in connection with concrete for flooring was made by the inventor in Chicago, and from that it has grown surprisingly, until at the present day it is being used to the extent of millions of feet, resulting in great economy of construction, and gives better construction for less money.

Following Mr. Watson's address, a series of pictures were thrown on the screen, which were explained by Mr. Bailey. Mr. Bailey afterwards, at the request of the Society, prepared the following paper for publication:

EXPANDED METAL CONSTRUCTION.

By William M. Bailey, Assoc. M. A. Soc. C. E.

Cement construction is at the present time attracting considerable attention. Concrete as a building material, both above and below ground, subjected to the action of the forces of nature, has shown such strength and endurance as to warrant its rapidly increasing use.

Most engineers are acquainted with the use of concrete in foundations and other structures where the stresses are compressive, and at intervals there has been presented for their consideration various combinations of plastic material and steel. Some of these are where isolated steel ribs act both in tension and compression and are stiffened with the concrete. In other systems, rods are placed in the tension side of the slab or beam, and designed to give tensile strength only to the structure. There are still other systems of concrete and steel, where the steel is in the form of sheets that are imbedded in the tension side of the concrete, which give tensile strength longitudinally and transversely, or in other words bonds the whole structure together, in one monolithic mass.

The expanded metal system belongs to this last named combination, and it is this system only which I wish to explain, as briefly as possible, describing some of its uses in engineering work, and giving the results of a few tests.

Expanded metal is made from sheet steel cut with the grain and expanded into diamond-shaped meshes, increasing the size of the original sheet from three to five times, according to the size of the mesh, width of strand, etc., without any waste of material. It can be made from any thickness of sheets or plates, but in commercial sizes we have from No. 27 to No. 4 gauge. The sheets are selected with care, and should be soft, tough, mild steel, as the elongation amounts to about 10 per cent. in spreading the mesh. It is sometimes asked if this shearing and stretching of the steel does not cause unnoticeable cracks which would reduce its tensile strength. An elaborate series of tests made at the Massachusetts Institute of Technology in 1897, and also recent tests, show conclusively that such is not the case, and that the metal sustains a tension of over 64,000 lbs. per square inch of section. Metal lathing is made from the lighter gauges of steel, No. 27 to No. 24, and is expanded only about three times the original size of the sheet of steel.

There is scarcely a prominent building in the United States of recent construction in which expanded metal lath has not been used in some form or other. When first manufactured, it was used merely as a substitute for wood laths, and securely stapled to wood studs it gave a perfect support for the plaster, and made a partition that resisted fire to a remarkable degree. Next came the use of iron and steel studs and furring irons; with these light rods bent to the right form and properly supported, almost any kind of architectural result can be obtained at a low cost. There are two kinds of partitions which are largely used by the leading architects in the United States; one is made of ¾ inch channel irons set vertically from 12 to 16 inches on centers, and lathed with expanded metal lath on one side. See figure 1. The whole is then plastered with hard mortar or Portland cement to a total thickness of 1¾ inches. This partition has given good satisfaction wherever used, and is light, sound-proof, fireproof, and less expensive than many others not half as good. The other style of expanded metal partition is made with a double row of ¾ inch angle irons, set and braced 12 inches on centers, lathed on both sides. See figure 2. When plastered it finishes about 6 inches thick, and has a clear space between angle irons of about 2½ inches for pipes, wires, etc.

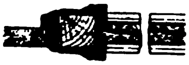


FIG. 1.

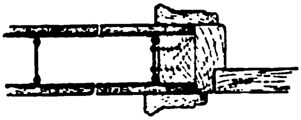


FIG. 2.

The metal usually employed in the construction of floors, roofs, and other concrete work, is No. 10 and No. 4 gauge, the short diameter of the meshes being three and six inches respectively, making a finished product eight to twelve times as wide as the original sheet of steel. For each foot of width the regular three inch mesh, No. 10 gauge, has a cross sectional area of .168 square inches, and the regular six inch mesh, No. 4 gauge, has a cross sectional area of .282 square inches.

Whenever steel or iron is used as a tensile member in a concrete slab or beam, or other structure, it should be held firmly in the mass by some means possessing greater strength than the adhesion between the concrete and the metal. Experiments in the laboratory show that the adhesion between steel and concrete amounts to over 500 lbs. per square inch, but practical conditions are entirely different, and from what I have seen, we should never depend solely upon this union, but the shape of the metal should be such that we get a mechanical bond with the concrete. In expanded metal the shape of the mesh is such that it cannot slip or be pulled through the concrete; concrete and metal have to work together—no sudden shock or continued vibrations can break their bond. One great advantage in the use of expanded metal is that it gives tensile strength not only lengthwise but transversely. It forms a blanket system, distributing the load in all directions, and as a monolithic slab adds stiffness to the whole building or structure.

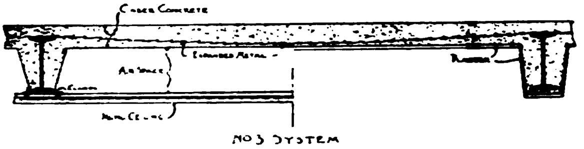


FIG. 3.

For fireproof floors, cinder concrete mixed one part cement, two parts sand and five parts cinders, is largely used on account of its lightness and great resistance to fire. It weighs about 100 lbs. per cubic foot and has an average crushing strength of 1200 lbs per square inch, and will resist the action of fire and water better than brick, stone concrete, or terra cotta. Tests show where all these have failed, cinder concrete has withstood the same fire test under the same load.

In work where greater crushing strength is required than can be obtained from cinder concrete, Portland stone concrete is used, it being about twice as strong in compression as cinder concrete. In all cases where expanded metal and concrete structures are built, we should first erect tight wooden centers or forms. The expanded metal is then laid upon this centering, and is so peculiarly made that it only touches the centers at one point in each mesh, which allows space for the concrete to be worked through and under the meshes, thoroughly imbedding the metal in the concrete as far from the neutral axis as possible, where its moment of resistance is greatest. Thus we have formed a composite structure, where the concrete resists the compressive strains, and the light sheet of expanded metal furnishes the tensile member. In joining one sheet of expanded metal with another it is only necessary to lap the sheets from 6 to 12 inches, and the concrete will bond them together so securely that the metal will break before they can be pulled apart.

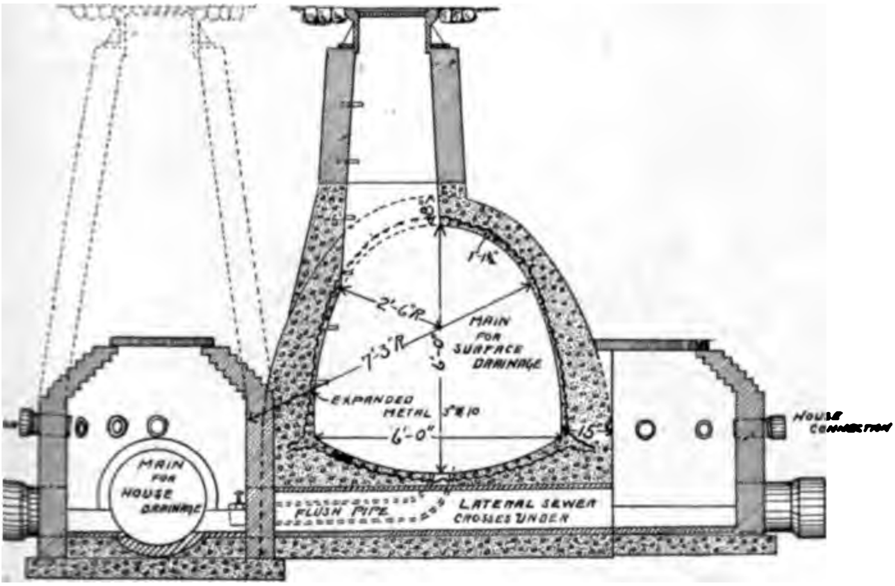


FIG. 4.

When the steel is properly imbedded in Portland concrete, we may feel sure that it will not rust, even if the same be submerged in water or sewage. This has been proven by the examination of steel taken from concrete-steel structures many years old.

The question which interests engineers mostly is, how much does expanded metal increase the strength of a concrete structure? Where crushing strength only is required, the expanded metal adds no strength, but in any structure subjected partly to

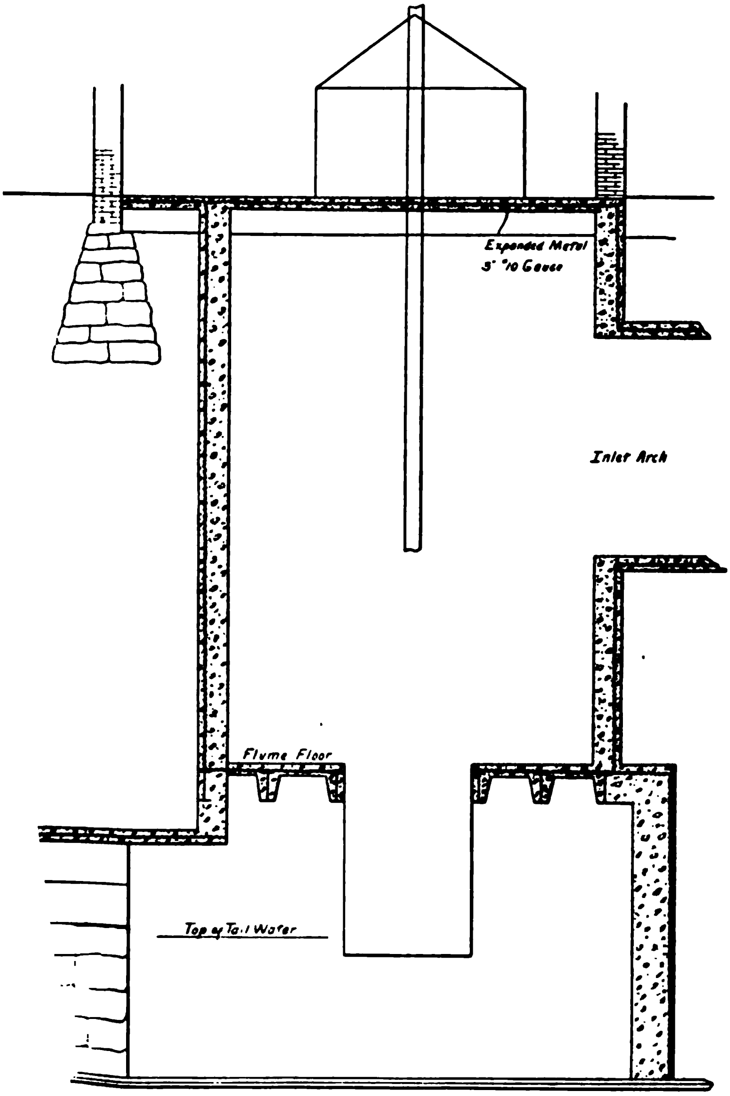

Expanded Metal
5" °10 Gauge
Inlet Arch
Flume Floor
Top of Tail Water

FIG. 6.

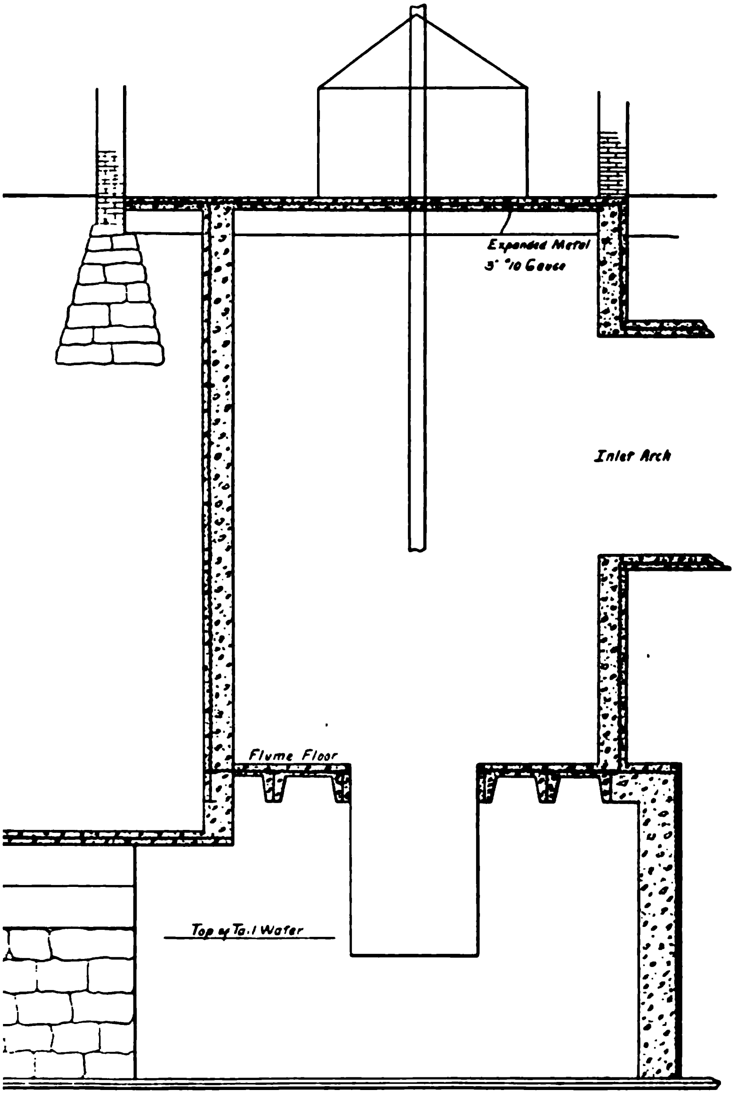

Expanded Metal
3" #10 Gauge
Inlet Arch
Flume Floor
Top of Tail Water

FIG. 6.

S equals the total safe stress on steel, equal to the cross sectional area times 16,000.

x equals the distance from the extreme fibre in compression to the neutral axis.

y equals the distance from the center of the steel to the neutral axis.

Now, $\frac{Cx^2}{3}$ equals sum of all the resisting moments on the compression side of the axis.

Sy equals cross-sectional area times 16,000 times y, which equals the total resisting moment on the tension side of the axis.

$$\text{But } \frac{Cx^2}{3} \text{ equals } Sy. \tag{2}$$

$$\frac{M}{2} = \frac{Cx^2}{3} \tag{3}$$

$$\frac{M}{2} = Sy. \tag{4}$$

Solve for x in (3), and then determine the relation of x to y, which varies with the moduli of elasticity of concrete (compressive member) and the expanded metal as a tension member.

Let $e =$ maximum strain on the concrete.

Let $F =$ maximum strain on the metal.

Let $mc =$ modulus of elasticity of concrete (assumed value for stone concrete of 1:3:6 1,000,000 lbs.).

Let $ms =$ modulus of elasticity of steel (30,000,000 lbs.), then by definition of modulus of elasticity.

$$mc = \frac{C}{e} = \frac{500}{1{,}000{,}000} = \frac{1}{2{,}000}$$

$$ms = \frac{C'}{F} = \frac{16{,}000}{30{,}000{,}000} = \frac{1}{1{,}875} \quad (C' = \text{stress per sq. in. on steel.})$$

$$\text{But } e : F = x : y, \text{ hence } \frac{1{,}875}{2{,}000} = x/y = .94.$$

$$x = .94y.$$

or, it is safe to say that for 1-3-6 stone concrete x is equal to y. Now that the relation of x to y is known, it only remains to solve for the proper cross-sectional area of the expanded metal. Then x plus y plus 1 inch is equal to the depth of the beam considered; the 1 inch is added below the metal to give the same a good grip in the structure and to protect the steel from fire and water or any corrosive action.

Actual tests show that there is greater strength in the expanded metal system than is indicated by this formula.

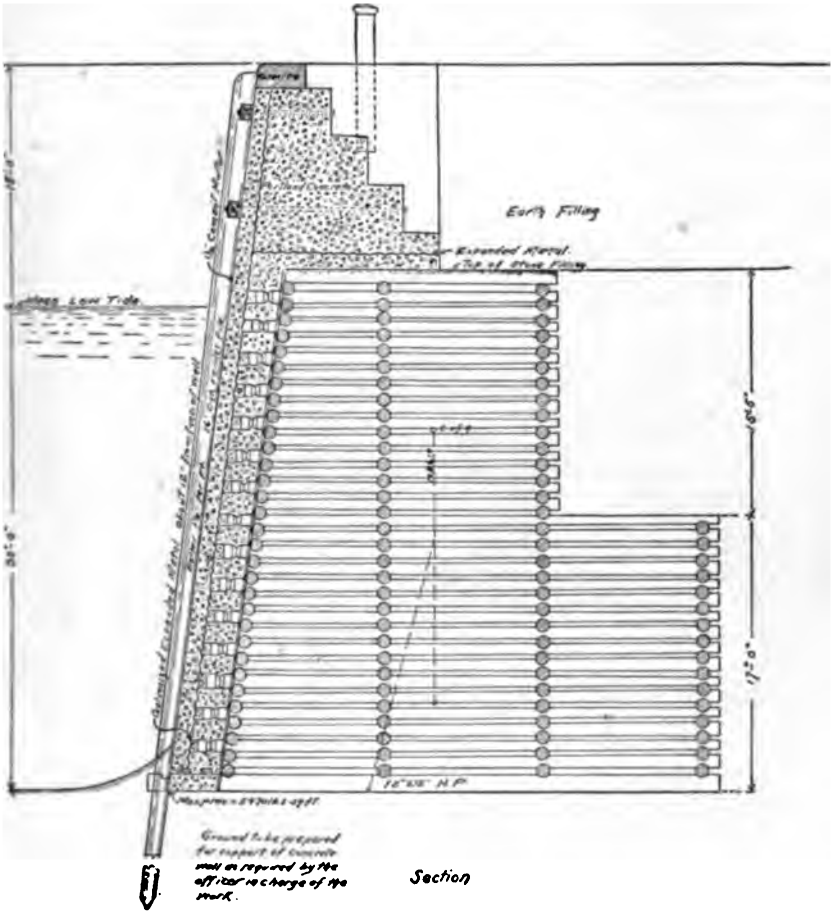

Earth Filling
Expanded Metal.
Top of Stone Filling
Mean Low Tide
12"x12" H.P.
Ground to be prepared for support of concrete wall as required by the officer in charge of the work.
Section

FIG. 7.

Expanded metal, made as it is in flexible sheets, can be adapted to any form of concrete construction, such as water pipes, conduits and sewers, arched bridges, circular or rectangular tanks and reservoirs, wheel pits, dams and retaining walls, and, in fact, to any concrete structure that needs a tension member. Concrete and steel have the same coefficient of expansion, thus work together under changes of temperature.

Mill engineers and architects are using this construction for floors in place of heavy brick arches sprung between I-beams, which cannot be spaced over four feet on centers. With the expanded metal system the spacing of the I-beams can be made from 6 to 15 feet, thus making a large saving in the steel alone, and also reducing the dead weight of the floors.

Many buildings for manufacturing purposes are now entirely constructed with this system on either wooden or steel frame.

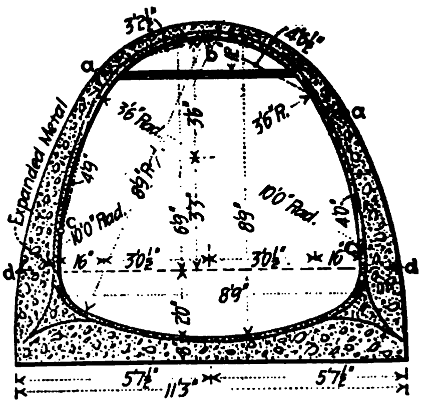


FIG. 8.

Curtain walls are made of light ¾ inch channels spaced 12 inches on centers, and lathed with expanded metal, and plastered with Portland cement to a total thickness of two inches. Buildings of this type have been constructed five stories in height, and are practically fireproof. The cost is about the same as that for mill construction.

At Rumford Falls, Maine, expanded metal has been made use of in a very interesting manner. About twenty-eight circular bleaching chests, twenty feet high and fourteen feet in diameter, were constructed entirely of Portland cement, stone concrete and expanded metal. The walls at the bottom were only six inches thick to sustain pressure due to a twenty-foot head of water. The expanded metal was placed near the outside shell of the concrete. These tanks are water-tight.

Concrete arch bridges are designed with long spans and small rise, with a minimum amount of concrete, if steel is so placed in the concrete as to take care of the bending moment at any section. The concrete alone is usually capable of resisting the direct thrust and shear at any section. In dams and retaining walls without support or tie at the top, the steel should be imbedded at the back side of the concrete and carried down into a concrete base under the weight or load. In this way a wall may be built twenty feet high, three feet thick at the bottom, which will safely resist the overturning moment due to pressure of twenty feet of water on the back side.

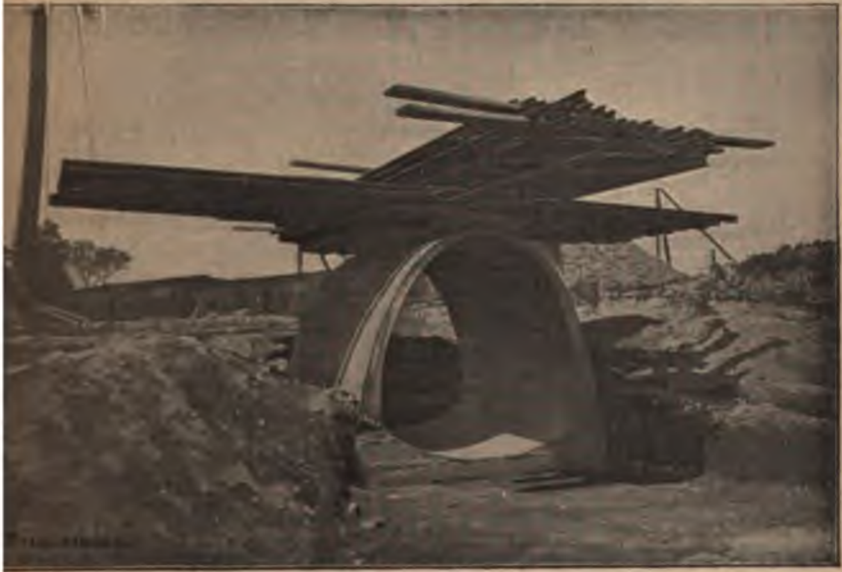


FIG. 9.

In figure 3 we have illustrated expanded metal and concrete floors. Figures 4 and 5 show some uses of expanded metal in sewer work. Figure 6 is a design for wheel-pit, etc., as built by the Massachusetts Chemical Co., who also built a concrete and expanded metal dam twelve inches thick at the bottom and ten feet high. Figure 7 shows a section of concrete and expanded metal facing for a timber dock built in Boston. Figure 8 is a section of a water conduit built for the New Jersey

Water Company, and in Figure 9 we have an illustration of the strength of this structure. When twenty-one days old, twenty-five tons of steel rails were placed on the three wooden saddles: carrying this load, it was subjected to an additional strain of one ton of rails dropped twice upon it from a distance of eleven feet without material effect. .

Below is a table of the results of a few tests which seems sufficiently conclusive evidence that there is a future for concrete and expanded metal construction. It remains only for the engineer to study each problem of construction and see to what extent concrete and steel may be advantageously used, always keeping in mind that the first cost of this construction is the only one. For references to steel concrete construction see "Doings of Expanded Metal," "Journal of the Association of Engineering Societies," February, 1901; "Engineering News," May 23, 1891; "Journal of the Western Society of Engineers," June, 1900; "Trans. of the American Society of C. E.," June, 1898, also "Engineering" (London), February 21, 1896.

Mr. D. Edgar Manson, of the Westinghouse Electric Co., was introduced by President Kellogg, and presented a number of views with explanations, illustrating the Niagara Power Plant.

Convention adjourned to 2 P. M. at Tontine Hotel.

The members and their guests then took cars, which were kindly provided by Mr. Parmelee, President of the Fair Haven & Westville R. R., to the power house, where Mr. Punderford and Chief Engineer Farnham took them over the station, explaining the equipment, which at that time consisted of three Allis engines, cross compound, condensing, 16" x 30" x 36"—(92) revolutions. Two other engines were in process of erection; size, 23" x 42" x 48"—(75) revolutions. Station equipped with jet condensers. Generators are direct connected, three of 225 K. W. Westinghouse and two are G. E. 525 K. W.

The boiler equipment is 10 Manning 125 h.p's. Each engine is furnished with an independent condenser. The stack is 140 feet with 6½' flue. An addition to the present station is now under construction; the building will be 100 feet long, and for the present will be equipped with two engines of the Allis type, 26" x 52" x 48"—(80) revolutions, with a battery of six boilers of 200 h.p. each. A new stack will be built 140 feet high, with

TESTS OF CONCRETE AND EXPANDED METAL FLOORS. FLAT SLABS SUPPORTED ON I BEAMS.

No. of Test	Span		Thickness	Mixture of Concrete			Days old	Equiv. dist. load per sq. ft.	Deflection.	Size of Metal		REMARKS.
	Feet	Inch	Inch	C	Sand	Cind's				Mesh	Gauge	
1	4	1½	3	1	2	5	30	2333		3 in.	No. 10	Cement used in all these tests was American [Portland.
2	4	1½	3	1	2	5	31	2354		3 in.	No. 10	Test made on same slab as above.
3	5	2	3½	1	3	6	30	715	$\frac{1}{16}$	3 in.	No. 10	
4	4	0	3½	1	2½	5	30	1750	None	3 in.	No. 10	
5	6	0	3½	1	2	5	30	1100	¼	3 in.	No. 10	
6	6	0	4	1	2	Rock 6	28	850	$\frac{1}{16}$	3 in.	No. 10	This floor had 1 inch granolithic finish.
7	5	4	4	1	3	6	30	914	$\frac{5}{16}$	3 in.	No. 10	
8	5	4	6	1	3	6	30	914	None	3 in.	No. 10	
9	11	0	6	1	2	5	30	360	$\frac{9}{64}$	2 sheets. 3 in.	No. 10	When load was removed $\frac{9}{64}$ in. deflection [remained.
10	4	0	2½				30	26	Broke	*No* Metal		
11	4	0	2½				30	256	"	3 in.	No. 10	
12	7	0	4½	1	2	5*	30	2440	"	3 in.	No. 10	
13	11	1	6½	1	2½	5*	35	1830	1½	6 in.	No. 4	This load after 3 fire and water tests. No cracks [from this load.
14	13		6½	1	2½	5*	30	900	Broke	3 in.	No. 10	1 in. granolith top.

an 8½ foot flue. Two G. E. generators of 825 K. W. and 80 revolutions will be installed.

The members returned to the Tontine Hotel, where dinner was served, during which an orchestra played selections and Mr. A. William Sperry rendered several excellent bass solos.

When President Kellogg called the meeting to order again after dinner, Messrs. Watson, Bailey and Manson expressed their thanks for the manner in which their papers were received by the Society.

By motion, a vote of thanks was extended to Messrs. Watson, Bailey and Manson for their services.

By motion it was voted, that the thanks of the Society be extended to President Parmelee of the Fair Haven & Westville Road for his courtesy in providing cars to the power house, and that the Secretary be instructed to so inform him.

The report of the Committee on the New Constitution was then taken up.

THE PRESIDENT: The Secretary will please read the report.

THE SECRETARY: Mr. President and Gentlemen—The Committee appointed in January, 1900, reported upon a revised constitution and by-laws. At the annual meeting of January 8th, 1900, they presented a draft of a new constitution and by-laws, copies of which were printed and sent out to each member for examination and reply. I will read first the Article and Section as presented by the Committee, and then the amendment as suggested by the replies which I have received.

[At the suggestion of Mr. Punderford, no one objecting, the President directed the Secretary to continue to read until a section was reached to which there was any objection or concerning which there were any remarks, when all the preceding sections would be put to vote, and the questioned section be then taken up.]

Article I, "Name and Object," was as follows: 'The name of this Association shall be The Connecticut Civil Engineers' Association." It has been, however, suggested by the New Haven members that the name, instead of being "The Connecticut Civil Engineers' Association" shall be "The Connecticut Society of Civil Engineers."

Then Section 2, Object, was read. Then Article II, Section 1, Membership, was read. Section 2, Members. Then Section

3, Honorary Members. Then Section 4, Associate Members, was read as follows:

Section 4: "Any person may become an associate member who is, by scientific attainments or practical experience, competent to coöperate with engineers in the advancement of professional knowledge and practice, but who is not a professional engineer; or also, any young man who intends to follow some branch of engineering, but who by reason of age or lack of experience is not eligible to admission as a member. Associate members shall have no vote, nor shall they be eligible to any office."

In the amendment, the only change is in the words, "also any young man"; that is changed to read, "or any young man who intends to follow some branch of engineering."

After considerable discussion, Section 4 was adopted to read as follows: "Any person desiring to become associated with this Society, who is not eligible to active membership, may make application, and if said application receives a favorable report from the board of direction, it shall be acted upon by the Society at the next regular meeting, and if said candidate shall receive a majority of the votes cast he shall be declared elected as an associate member. Associate members shall have no vote, nor shall they be eligible for any office."

Article III, Section 1, Officers, then read.

Section 2, Election of Officers, then read as follows: "The officers, excepting the assistant secretary, shall be elected at the annual meeting only, and shall hold their respective offices until the final adjournment of the meeting in which others are elected and qualified in their places."

In the first section there is nothing but the necessary change in the name, and in the second the form is amended by striking out the word "only," so as to have it read: "The officers, excepting the assistant secretary, shall be elected at the annual meeting."

Section 3, The President, then read.

Section 4, Vice-President, then read.

Section 5, Secretary, then read.

Section 6, Treasurer, then read.

Section 7, Assistant Secretary, then read.

Section 8, Board of Direction, read as follows: "This Board shall consist of the president, the two vice-presidents, and the four directors. It shall have supervision and care of all the affairs and property of the Association, and shall conduct the same in accordance with the Constitution and By-Laws. The president or one of the vice-presidents shall preside at all meetings of the Board, in the order of seniority. In the absence of all these officers a chairman *pro tem.* may be appointed for the meeting. The first year after this section is adopted, four members shall be chosen at the annual meeting, one from each Congressional district: two shall be chosen for a term of one year and two to serve two years. At all subsequent annual meetings two members shall be chosen to serve two years, preserving, always, the representation from each Congressional district. Four members shall constitute a quorum to transact business."

In the amended Constitution that section is left just the same, except that in the last part of it the words "one from each Congressional district" are stricken out, and the words "preserving, always, the representation from each Congressional district." That is stricken out also. That is all there is to Article III.

THE PRESIDENT: Gentlemen, you have heard these sections read of Article III: also the amendments. What is it your pleasure to do with them?

A MEMBER: I move the adoption of Article III.

THE PRESIDENT: Under which head?

A MEMBER: Under the last head: the way it's suggested to amend it.

THE PRESIDENT: Is there any other modification suggested in Article III?

THE SECRETARY: Nothing only to strike out that about the Congressional districts. And the word "the" is inserted before the words "four directors" in the second line.

THE PRESIDENT: The idea is this: we may have five Congressional districts, and if that is left in, it may hamper us in the selection of the men. It wouldn't be very convenient to have this section call for four directors, one from each district, and have five districts. If there is any reason hereafter for putting in "Congressional districts" here, a resolution to that effect will be just as much in order then as it is now.

MR. VORCE: Mr. President, I move that Article III be accepted, except in Section 2 strike out the word "only": in the last part of Section 6 insert the word "annually," so the board of direction shall audit annually, and in Section 8, strike out "one from each," etc., and "preserving, always," etc., and substituting "Society" for "Association," where necessary.

Motion passed as stated.

THE SECRETARY: "Article IV. Elections—Officers. Section 1: At each annual meeting the Association shall elect a president and a secretary and treasurer to serve one year; also two directors to serve two years. The president shall be ineligible to immediate re-election after serving two terms."

I would state that I think there is an omission there, as it says nothing about vice-presidents.

THE PRESIDENT: Where do you mean?

THE SECRETARY: It says nothing about the election of any vice-presidents in that article of the Constitution. I think that is an omission.

THE PRESIDENT: They should be put in.

Section 2: "Elections. How conducted," was then read as follows: "The election of officers, except the assistant secretary, shall be by letter ballot at the annual meeting. The polls will close at eleven o'clock in the morning on the day of the annual meeting."

Then there is an amendment which takes the place of this next paragraph of Section 2. The section in the committee's report is: "The presiding officer shall appoint tellers to canvass and report in writing, in detail, the number of votes cast for each officer, and the presiding officer shall announce the result at the meeting." That, in the amendment to the second part of Section 2 is entirely changed, and reads: "At a previous meeting the society shall choose a nominating committee of five, who shall submit to the secretary, not less than sixty days before the annual meeting, the names of three candidates for each office. Letter ballots shall then be sent by the secretary to each member at least thirty days before the day of the annual meeting. Each ballot shall be returned to the secretary enclosed in two envelopes; the inner one to be blank, and the outer one to be endorsed by the sender."

THE PRESIDENT: I think that is about enough to discuss at present. This was taken from the Boston Society, if I remember correctly, and there was a ballot submitted that is sent out by this committee of five. This committee nominates three men and prints their names on the ballot, and below the names there is a blank space left for a member to fill in another name that he choses to vote for, or if he doesn't care to take any one of the ones nominated. That is supposed to fix the minds of the members on those particular ones who are eligible, and not only eligible, but as members that would be preëminently fitted for the particular places. These blanks are sent out, three men being nominated in each instance, and the man, or the one you choose to vote for is indicated by a cross opposite the man's name, or you can write in your own choice and indicate that you vote for him.

The reason for using two envelopes, which seems cumbersome, is this: the envelope on the outside is addressed to the secretary in order to get it to him. That is the one that the secretary receives. You put your name on it. After the secretary finds that the man is in full and regular standing, he marks it "O. K.," and it's ready to be handed to the tellers and canvassed at the election, no name appearing on the envelope going to the tellers. It is in a sense a secret ballot, and the tellers will have no occasion to know who voted, or how they voted. The reason I explain this is, because the member who submitted this style of ballot is not here, and he asked me to say something about it. Whether you think that is too much to be done at this time is a matter for you to say. I would like to hear your ideas about that. Mr. Ford, you are from Mr. Bunce's office. Have you had any discussion with him about it?

MR. FORD: No, sir, I haven't had any with him. I know that Mr. Graves came up there to see Mr. Bunce about it. They thought it might be a good scheme not to have any committee, but to send out simply a blank ballot in order to get a personal opinion as to candidates from every member of the Society, and then take those that had the highest number of votes. That is the way it was originally planned, I think. They thought perhaps you would get a better expression of opinion from every member of the Society in that manner, and the candidates would not be simply the opinion of the five members who composed the committee. They thought it would be more representative, and it would be better to get the individual opinion of the members without any committee. I remember that is about the way they talked of that particular section. I didn't follow it out to see how those five members were to be nominated in the first place. Is that by the board of direction?

Mr. Vorce: No, that is done at the meeting before. The meeting before nominates the committee. The article provides that the Society as a whole shall appoint the five members.

Mr. Ford: They shall elect the five members; that is at such meeting, or at the annual meeting?

The Secretary: It says "the previous meeting."

Mr. Ford: I shouldn't think that was very clear.

The President: Why not say at the annual meeting instead of at the previous meeting?

Mr. Ford: The previous meeting might be taken to mean any meeting that had intervened before the election. There might be special meetings.

The President: I should think before the annual meeting would be better. If you adopt it, it would be better to say at the meeting before the annual meeting. The election is at the annual meeting.

A Member: That is, have the committee, if you are going to have a committee, appointed at the regular meeting before the annual election?

The President: I think that is a good scheme.

Mr. Vorce: These five members are elected by the Society as a whole, and the committee chooses those members who are deemed fitted for the offices. In that case any nomination they make is merely the opinion of the individual members.

Mr. Ford: I think that necessarily precludes the getting of anything like the honest sentiment and opinion of the members on this matter. After the letters were sent out you would get some replies from the members, but you wouldn't get much advice as to who they wanted for office.

Mr. Vorce: While the nominations would express the individual opinion of the committee, I think if you left it to the Society as a whole, to nominate the members that they wanted as candidates, you would have fifteen or twenty nominees, and you would have to proceed in the same old course that we do in every annual meeting now. This doesn't impose candidates upon anybody who doesn't want them, but it simply gives the members a chance for an expression as to the members, or men who have been nominated by the nominating committee. I do not think it takes away any of the powers of any member of the Society. A member is his own free, active agent to vote as he sees fit, just the same as he was before. It is more suggestive than otherwise. It simply gives a member a little pointer if he wants a pointer. If he doesn't want it he can put down whom he wants.

Mr. Ford: If you send out this letter, and you only have fifteen or twenty answers, how would you proceed then?

The President: This section attends to that. It says that the ballots shall be returned to the secretary, so that wouldn't have any effect on the original way, or the amended way. It would work in one case just the same as in the other.

Mr. Snell: I was going to say, Mr. President, that if you do not have any way of nominating these members, you will never have an election, for the next section provides that a majority shall elect. You wouldn't get it. If you had fifty votes you might have fifty men voted for, and much more likely to be so, I think, than that there would be a majority for anyone. There never would be an election.

Mr. Vorce: That objection of Mr. Snell's, that it would amount to a plurality electing instead of a majority, relates to something which will come a little bit later. Still, it's a very good point to raise, and I think it's a very pertinent point. That is modeled somewhat after the method of the American Society of Civil Engineers. They nominate and leave a blank space for any name that any member might wish to suggest, and proceed then just the same as we do. The votes are opened at the annual meeting, and the officers elected the same way.

A Member: Does that majority mean a majority of the votes cast, or a majority of the members?

The President: A majority of the members. If they don't choose to vote it's counted blank.

Mr. [illegible]: I think it has always been the custom that the vice presidents are promoted from year to year. That has generally been the case. Now it seems to me it's rather unnecessary to have the nominating committee to nominate two men for the first two offices, and a third man, when the man that is not a vice president is practically sure of getting turned down. I should think if this applied to the offices except the vice-presidents, it would answer every purpose, and still leave a blank space for anyone to vote for another, if he wishes.

THE PRESIDENT: That hasn't been the set custom of the Association, because the contrary has happened several times.

A MEMBER: Why do we make these nominations so long beforehand? Can't we do it all on one day just as well?

MR. VORCE: There is another point which seems rather peculiar to me, and that is, in the American Society it has always been the custom, and I don't know but that there is a by-law to that effect, whether a man is eligible to be elected the second time or not, but the fact is they never are. Now, of course, that is a large society, but this Society is growing every day. Two or three years ago you only had thirty-six members, while now you have two hundred. It seems to me it would be well to limit the president's term to one year instead of two years. That would give everybody a chance. I would like to suggest that and see what the members think of it. It would remove some of this trouble about a committee, for the president would not be renominated.

A MEMBER: I think I agree with you. More interest would be taken, and you would get better work from the officers if their term of office were shorter. Then again, as a rule, most active officers are business men, and they do not generally care for a second election, but if their friends want to push them, in a majority of cases they do not like to decline.

THE PRESIDENT: I shall not be to blame if I don't get out next year. A man has to be president once to know how he feels about it. I do not think any man will seek the office a second time, because that same feeling, and it's a proper one, that the office should go around, will be with him all the time. I think it would be perfectly proper to have this understood, but I don't think it ought to be put into the Constitution. Anyway, the matter of re-election after two terms, it seems to me, might as well be left out. I think if you are not going to say that the president shall have no more than two terms it would be better to strike it out altogether, as then custom would say that he should not have more than one.

MR. CRAWFORD: Mr. President, I would call for that amendment, and I'll move to strike out entirely—that the president shall be ineligible after two terms.

Motion seconded and passed.

MR. BISHOP: I move that clause relating to a nominating committee be stricken out.

Motion not seconded.

MR. SNELL: Mr. President, I move that Section 2, as amended, be accepted as read.

Motion seconded.

MR. VORCE: Don't you think you would better use the word "annual" there so as to make it read at the "annual meeting" instead of "at the previous meeting."

MR. SNELL: Why couldn't you say "annual meeting after 1902?"

THE PRESIDENT: You could put it at the previous meeting and subsequently at the annual meeting. Is that accepted by the one that makes the motion?

MR. SNELL: I think that would be all right.

Motion passed.

Section 3. Members in arrears, etc.—then read and passed.

Section 4. Majority elects—then read and passed.

Section 5. Notification—then read.

Section 6. Vacancies—then read as follows: "Vacancies occurring for any cause in the list of officers shall be filled by the board of direction 'by some active member, who shall serve out the unexpired term.' "

In the amended copy, the words after "direction" are stricken out.

MR. VORCE: I move that Section 5 be accepted as read, and Section 6 as amended.

Motion seconded and passed.

Section 7 then read as follows: "Members may be elected to any grade at any meeting of the Association, a notice of which meeting having been sent to the Post Office address of every member, ten days in advance. Any candidate having five negative votes shall be rejected, and no rejected candidate shall be eligible for election for one year. In case of rejection no minute shall be published, but the secretary shall notify the applicant by letter."

As amended, this section reads as follows: "Each application shall be announced on the notices for the next meeting after it is received, shall then be considered by the board of direction, and, if approved, shall be presented to the Society for ballot at a regular meeting. If the candidate receives not more than four adverse ballots he shall be declared elected."

After much discussion, a short recess having been taken, there being no quorum, the meeting was again called to order at 4.45, in one of the parlors of the Tontine, and Section 7 was adopted to read as follows: Section 7. Election of Members—"Each application shall be announced on the notices for the next meeting after it is received, shall then be considered by the board of direction, and, if approved, shall be presented to the Society for ballot at a regular meeting. If a candidate receives a majority of the ballots he shall be declared elected. In case of rejection, no minute shall be published, but the secretary shall notify the applicant by letter."

Section 8. Applications for Membership—then read and passed.

Article V. Meetings.

Section 1. Annual Meeting—then read.

Section 2. Special Meetings—then read as follows: "Special meetings may be called by the president, and when so called, notice of the meeting, specifying the business thereof, shall be mailed by the secretary to the Post Office address of each member at least ten days before such meeting shall be holden. Special meetings shall be called by the president on written application of any five members."

The amended Constitution changes the word "holden" to read "held," and in the last clause it is changed so that special meetings shall be called by the president on the application of ten members.

Section 3. Quorum—then read.

Section 4 then read: "The opinion of the Society may be expressed on subjects affecting the public welfare, provided that this opinion does not carry with it the promotion of the interests of any individual, firm, association, or corporation."

All the difference in that is the word "Association," which is changed to "Society."

By motion it was voted that Article V be adopted as read with Section 2 as amended. By motion it was voted to reconsider and amend previous action and strike out Section 4 entirely.

Article VI. Entrance Fees and Dues—was then read as follows: "Section 1. The annual dues of active and associate members shall be $3 per year, payable in advance at the annual meeting. Members elected at any time of the year shall pay full dues for that year.

Section 2. Honorary members shall pay no annual dues.

Section 3. The board of direction shall have power to remit dues upon application in writing, stating the reasons therefor."

Motion duly made and seconded that Sections 1, 2 and 3 be accepted as read.

By vote, this was amended to strike out all after "dues" in Sec. 3 and to insert therefor, "when, in their opinion, it will be for the best interests of the Society."

Article VII. Deprivation of Membership—then read as follows: "Section 1. Any member whose dues shall remain unpaid for one year shall be notified by the treasurer, by sending by registered mail a bill for dues in arrears, on the face of which bill shall be printed the sections of the Constitution covering such cases. If the dues are not paid within thirty days after such notification, the matter shall be presented to the board of direction for their action."

By motion, it was voted to amend by inserting two years for one year, and to strike out all after "direction" and insert therefor, "who shall have the power to drop such member from the [illegible]."

Section 2. Resignation—then read as follows: "Resignations must be submitted in writing, and may be accepted by the board of direction when all indebtedness to the Association has been discharged."

[illegible] amend by inserting after "writing" [illegible] the Secretary."

[illegible] passed.

[illegible] Constitution. Sections 1, 2 and 3 [illegible]

[illegible] by-laws be adopted with [illegible] them conform to the text

[illegible]

PROCEEDINGS

OF THE

SUMMER MEETING

HELD AT

Norwich and New London, August 27, 1901.

The members and guests to the number of 75 met at the new plant of the Continental Compressed Air Co. at Taftville about 11 A. M., and were cordially received by Col. John A. Inslee, the General Manager, and Herbert M. Knight, the resident Engineer. The plant, which was then in course of construction, was novel and most interesting, and it was hoped that the Society would be able to have a description of the same to print in the Report.

At noon the members boarded the train and were taken to New London, where the Government tug Castle was in waiting to take the party for the afternoon programme.

They were first taken across the river to the works of the Eastern Shipbuilding Co. in Groton, where, through the courtesy of Mr. Chas. A. Hanscomb, President, they inspected the two steel steamships being built.

When the party returned to the steamer, lunch was served while making the trip across the Sound to Fort H. G. Wright on Fisher's Island.

Special permission having been secured from the Secretary of War, the party was shown around the new fortifications then in course of construction,

Through the courtesy of Maj. Smith S. Leach, Corps of Eng., this part of the trip was made very interesting and instructive, and much credit is due to him for the many favors in the way of transportation, as well as the clear and pleasing way in which he described the works and the methods employed.

The steamer then took the party back to New London in time for the evening train.

Through the courtesy of Mr. C. C. Elwell, Asst. Supt. of the Shore Line Division N. Y., N. H. & H. R. R., a special train was provided from Norwich to Taftville and return, and through the courtesy of Mr. W. L. Adams, Supt. of the Norwich Street Ry. Co., a special trolley car was provided from Baltic to Taftville.

Mr. Geo. S. Miller and Mr. Fred L. Wheeler were elected as active members.

The following Nominating Committee was appointed to send in nominations for officers for the ensuing year: C. H. Bunce. J. C. Tracy, C. E. Chandler, E. P. Augur and Norman McD. Crawford.

Votes of thanks were passed as folllows: To the Continental Compressed Air Power Company; Assistant Superintendent C. C. Elwell of the N. Y., N. H. &. H. R. R. Company; to Superintendent W. L. Adams of the Norwich Street Railway Company; the Eastern Shipbuilding Company, and to the local committee of arrangements.

REPORT OF THE PROCEEDINGS

OF THE

Connecticut Society of Civil Engineers

AT THE

Eighteenth Annual Meeting held at Hartford, Conn.,

February 11th, 1902.

Convention called to order at 10.35 A. M., President Henry J. Kellogg of New Haven in the chair.

The President appointed Mr. F. L. Ford to assist the members of the Executive Committee, Messrs. J. Frederick Jackson and L. E. Daboll, to audit the accounts of the Treasurer.

A short recess was taken, awaiting the report of the Auditing Committee.

Meeting called to order again, and by motion, it was voted to accept the minutes of the last meeting without reading, and order them printed in the annual report.

Since the Board of Direction was not called into existence until after this meeting, they presented no report.

The Executive Committee presented the following report:

To the President and Members of the Connecticut Society of Civil Engineers:

GENTLEMEN:—Your Committee held three meetings during the year, the first at the Hotel Garde, New Haven, March 16, 1901, when arrangements were made for holding the spring meeting at New Haven; the second at City Hall, New Haven, on July 23, 1901, to arrange for holding the summer meeting at Norwich and New London, and for supplying the members with copies of the new Constitution and By-laws; and the third at

New Haven, January 11, 1902, to arrange for holding the eighteenth annual meeting of the Society at Hartford.

Respectfully submitted,

HENRY J. KELLOGG (*ex-officio*),
HERBERT C. KEITH, New Haven,
NORMAN MCDONALD CRAWFORD, Hartford,
LOREN E. DABOLL, New London,
J. FREDERICK JACKSON, New Haven,
Executive Committee.

The following report was submitted by Secretary George K. Crandall:

NEW LONDON, CONN., Feb. 11th, 1902.

To the Officers and Members of the Connecticut Society of Civil Engineers:

GENTLEMEN:—The seventeenth annual report of this Society, containing the proceedings of the spring and summer meetings of 1900, and the seventeenth annual meeting held at Hartford, Conn., January 8th, 1901, was printed early in the spring of 1901, and sent out to all the members, as well as to the societies with which we exchange.

The spring meeting for 1901 was held at New Haven on April 20th, at Sheffield Hall.

The summer meeting was held at Norwich and New London on August 27th, and was attended by about seventy-five members and guests.

An important feature of the year's work was the adoption of a new Constitution and By-laws, at the spring meeting, some of the provisions of which cannot be fully in force until the election to-day of the Board of Direction, which takes the place of the Executive Committee.

The new Constitution and By-laws have been printed and sent to every member.

I wish to call the attention of the members to the fact that the reports for the past two years have cost the Society much more than in previous years, as they have been much more voluminous, and have contained many more illustrations and tables. This was considered by the Managers to be desirous, and I am sure that it has been appreciated. This increase of cost has been largely met by the extra advertisements which have been secured through the efforts of the President and Secretary, but I would suggest that each and every member might aid in this work by including some dealer or contractor in his section to advertise in our report.

The increase in membership during the past year has been very encouraging. There have been three honorary members, two associate members, and thirty-five active members elected.

One honorary member, Mr. Robert R. Smith of New Hartford, died May 12th, 1900, but his death was not reported to your Secretary until 1901.

Four active members have withdrawn from membership during the past year. The membership now consists of nine honorary, two associate, and one hundred and ninety-eight active members, a total of two hundred and nine.

Respectfully submitted,

GEORGE K. CRANDALL, *Secretary.*

By motion, it was voted that the report be accepted and printed in the annual report.

The Auditing Committee not being quite ready, the report of the Treasurer was passed over and the Reports of Special Committees taken up.

On motion of Mr. Bunce it was voted that the reports of special committees be read by title and the reports printed in the proceedings of the meeting for distribution and discussed at the next meeting.

REPORT OF COMMITTEE ON FIELD WORK.

To the President and Members of the Connecticut Society of Civil Engineers:

Your Committee would beg leave to submit the following report: In accordance with the request of the President we have endeavored to obtain information, but have met with but little success from the members of the Society.

Your Committee wish to express their thanks to Mr. John F. Fairchild, C.E., of Mount Vernon, N. Y., for his article on "Plotting," to Mr. Walter A. Miles, C.E., of Mount Vernon,

N. Y., for his paper on "Common Sense in Field Work," and to Mr. Frank L. Clapp, C.E., of Waterbury, Conn., for his "Description of a Leveling Rod" and drawings.

In Mr. Fairchild's reply to the request of the committee, he gives the following:

In the matter of field methods or instruments, I cannot at this moment make any suggestions as to any novel method or instrument which is not somewhat generally known, with the possible exception of one.

Sometime since I had occasion to plot a large number of property boundary descriptions in compiling the holdings of an estate in West Virginia, and I found the customary method of plotting, either by deflection angles or by laying out all the courses from a north and south line, and then paralleling down to the proper point on the map where the line was to be drawn, to be very slow and cumbersome for the amount of that class of work to be done; so I devised a universal protractor and scale plotter, by taking a regular protractor and drawing to or near the center sufficient of the lines so that the degrees and fractions of degrees could be readily traced from the center to circumference of the protractor. I also drew upon the protractor circles at regular distances from the center for the scale upon which I was making the plotting. I then made my plottings upon the tracing paper or cloth by drawing a line at random on the paper, and taking a point of that line as the starting point. I then scaled off on this line the distance of the first course, and placed the end of the course on the center of the protractor with the line covering the proper angle course as shown over the proper degree upon the protractor. From the center I could therefore quickly draw the line in the correct direction, and upon this line mark off from my distance circles the correct distance of the second line. I would then slide my tracing paper so that the end of the second line coincided with the center of the protractor, the line covering the proper angle on the protractor, and from the center draw the line in the proper direction for the third course, marking off the distance from the distance circles, and so on proceeding around the property. I found that this method was as accurate as work done by the ordinary means of plotting, the same care being used in both cases, and it saved very materially upon the time required to plot the property. It is, of course, not as accurate as a coördinate plotting, but for the general plotting of deed descriptions where you do not require extreme accuracy, it will do.

"Common Sense" in Field Work.

W. A. Miles, C.E., Mt. Vernon, N. Y.

Great regard has always been paid to the man who "calls a spade a spade," but the practical mind goes a step further and pays homage to the man who *makes* a spade a spade. In elucidation of the foregoing assertion, let us consider the chances of employment on a work of excavation, between Mr. Thomas Costigan (No. 17 on the payroll), who elevates a heaping shovelful of earth every twenty seconds of the day, without complaining of a strained back or losing the fire from his pipe, and Mr. Penny, who, utilizing a bank holiday in preparing a flower bed in the front yard, reduces the capacity of the same shovel to that of a tablespoon and wastes energy enough to develop a golf course; yet were either to be asked whence the difference, a good reason would be hard to get. Now, what is true of the shovel and its use, is true of every tool and instrument in every and any branch of business; but for the purposes of this discussion, let us make the application where it will appeal to us and to our pocket books in the conduct of field work.

The average transitman, if ordered to equip his party for the survey of, say, sixty acres of farm land, surrounded by crooked stone walls and streams, and well grown to brush and timber, would make out a list which would include the following:

1 Axe.
2 Bush-hooks.
1 Light Bar.
2 or 3 Ranging-poles.
2 Stone Chisels.
3 Plumb-bobs.
Pins.
Tacks.

Bag containing:—

1 100 ft. Steel Tape.
1 50 ft. Cloth Tape.
Red and White Cloths.
Angle Mirror.
Spool of Bob-cord.

Now, if the statement that "an axe is an axe" holds good, the rear chainman can usually complete the list in half a day. On the other hand, if the highest efficiency is desired, close attention to the quality and construction of the various tools and instruments, and after this, their care, will always prove a good investment. Let us consider this more in detail.

Naturally, portability and lightness are very strong factors in the case; but the sorry aspect of a hub set at a critical point some six or eight months, in frosty ground, battered with an axe resembling a lathing hatchet, till more useful as a paint brush than as a receptacle for the now invisible tack, will lead us to think twice on the subject. The axe, then, should be one with a three and a half or four pound head, a well-shapen, straight-grained handle and a fairly broad surface for driving the stake. The bush-hook should be not too light, should have a large, open curve in its cutting edge, extending about four or five inches from the line of the straight cutting edge. The bar should be of the best steel, about five feet long, of ¾ inch or ⅞ inch diameter, octagon. The chisels should be of the same stock as the bar and about seven or eight inches long. The plumb-bobs should be not less than twelve ounces and have a true concentric taper from the largest diameter to the point: this will enable the chainman much more accurately to determine the direction of the bob in different positions. In the matter of bob-cord, braided linen fishing line will prove most satisfactory, as it does not rough up under exposure or show any tendency to twist, thus keeping the bob under constant motion. As to tacks, it is advisable for the surveyor to use some distinct kind of tack, even at a little extra cost, as he can then identify his own work anywhere. In the selection of pins and ranging poles there is little that need be arbitrary, excepting that the "shoe" on the pole shall have its point in direct line with the center of the pole in any direction. This can be determined by setting the point of the pole on the floor and "spinning" it, looking for lateral motion, which should not exist. The rags are for distant signals and for occasional wiping of the tape after a morning's work in dewy grass.

None of the heavier of these tools is in fit condition for use, as it comes from the store and it remains for the grindstone and the forge to complete the work. Here is where genius and experience find an opportunity to exhibit their art. The bar and the chisels first go to the blacksmith, but not without explicit directions for their treatment. The "point" of the bar should begin in a hardly perceptible taper, about four inches from the end. About an inch from the end, it should be tapered abruptly, but not to a point: this should be consummated in the last ¼ or ⅜ inch. The pointing process being completed, a "pigeon blue" temper should be given for as great a length of the bar as possible, and you have a light and portable instrument that makes all soil "loamy" and whose uses are well nigh illimitable. It will bend, if over-taxed, but seldom break: if it does, its sharp, but thick, point will not lose much of its length.

The chisels should be brought to an edge in three inches of their length, and a "copper" temper given, after which they should be taken to the grindstone and brought to an abrupt edge in the last ¼ inch of their length.

What is good practice in the grinding of the chisels is also applicable in grinding the axe and bush-hooks. They should be ground to a true taper on either side, back for about half an inch from the edge and then brought to a quick edge in an eighth of an inch. This insures a straight face, which will follow a cut once started; a sharp and wedging edge, yet one of sufficient thickness so that a false stroke against a stone will not cause a "gip" so deep as to make a large expenditure of time and material necessary.

With proper tools, properly prepared, there is nothing to detract from the comfort and efficiency of a field corps, unless it be the man who doesn't know how to use them; and, in these days of deserted farms and undergraduate chainmen, he is becoming an omnipresent factor. The young athlete who wins a medal or two for juggling the Indian clubs most surprisingly, will handle an axe or a bush-hook about as adroitly as he would a scuttle of coal; yet, call his attention to the curve in the handle and then to the warped duplicate of the button he found so useful on the Indian club,—let him perform the same evolutions with them as with the clubs, as he can, and the stiffness which formerly impeded him and fatigued him gives way to the easy and graceful movements that are the magic of the man who knows how.

How many men who handle an axe know why the handle is "dropped" and why the little button is always on the end thereof? According as the man is right or left-handed does he place his right or left hand respectively near the head of the axe, while the other hand grasps firmly the button. The former hand does the "pushing" and, once having started the axe on its errand, should be allowed to relax somewhat and slip toward the other hand, the body, meantime, swinging slightly to add length of amplitude and weight to the blow, which is now entirely in control of the hand on the "button," which was put there for that very purpose. When the axe strikes, it cuts *wood* or drives a stake and does not devote its energy to imparting a headache to the operator, as would be the case were the hand nearer the head of the axe allowed to remain there. If a stake is being driven, it is desirable to hit as squarely as possible. To this end, the back may be bent or the "button" hand raised or lowered just before the contact. If it be desired to bring the stake to line, that may be accomplished, usually in the same way: the stake is going downward all the time and that is the prime object. In the sharpening of a stake, one hand is on the axe while the other holds the stake. In this case, the novice will have the button up under his armpits: the artist (but this takes muscle born of practice) grasps the handle midway and swings the axe well above his head, delivering and directing the blow with one hand.

What is true in the handling of the axe is also generally true in the handling of that very efficient tool the bush-hook. In proper hands, a good bush-hook will do about everything, except driving the stake, that an axe will do. It will fell a sapling of four inches diameter just as easily as it will mow a clean swath through tender meadow grass.

In using the hook on bushes and saplings, the operator should stand erect and deliver the hook with the edge pointing upward, almost broadside. At the contact, the body, which has been following the blow, should be thrown still further backward, imparting a sort of "yank" to the action of the hook, which works wonders. In grass and low weeds, the hook should be carried with the edge presented directly to the work; the back should be well bent and the long drawing out of a scythe imitated as nearly as possible.

The bar is useful in stubborn ground in making holes for stakes, in removing stones and, in winter, in getting through the frozen ground. Here the "button" hand and its brother perform similar functions as with the axe. The hand near the top of the bar remains there, the other hand doing the guiding.

Let us now consider the procedure when the use of the contents of the tool-bag is involved. Generally, the first thing done, after entering the field, is the setting of a hub at the initial point of the survey.

This is usually cut from a tree, preferably of cedar or locust, but oftener of oak, hickory, maple, etc., *ad infinitum,* according to surroundings; but better than any of these, is a well defined mark chiseled on a ledge or boulder. When this is to be done, the manner of using the chisel is important. It should be held a little off the stone for the first few blows until the mark is well defined; then the chisel should be started near the surface of the rock and given a shaving action as it is driven to the bottom of the "V"-shaped cut, first on one face thereof and then on the other. In this way, a good, clean cut is assured and the edge of the chisel, so far as possible, preserved.

After the taking of the first angle, follows the measuring of the initial line of the survey. This is seldom on ground that, in anyway, resembles a tennis court, and the desirability of experienced and practical men is here much emphasized. In the first place, the tape must, at all times, be used as near level as possible, but the optical illusion which a long, sloping field presents is all too familiar to us all. If there is a building in proximity, the tape may be made to parallel its siding; the transitman can direct the men in this matter, if they be near the level of the plate or telescope; but in the absence of these controlling factors, the production of a right angle between the tightened tape and the bob-cord, which is surely plumb, is a method always possible and practical.

Another desirable thing is, steadiness in the handling of the tape. Two experienced men, accustomed to working together, will maintain a uniform strain, one giving as the other strains beyond this limit, thus unconsciously conducting a sort of telegraphic code and maintaining a stable tape, no matter what the position or condition. But for the novice other means must be resorted to. In the first place, the position of his body and of his feet is important. He should stand facing the tape and in such a position that he might read it. The foot nearer the other man should be placed well out from the body, as a brace; the tape should be held firmly by the hand away from the other man, which takes the bulk of the strain; a turn or two of the tape within the case helping the head man, who should hold the case by the last three fingers, catching the open handle between or against them, and holding the tape between the thumb and forefinger near where it leaves the case, enabling him to pinch the bob-cord at the intended mark, when all the attention may be given to the bob, which, we shall agree, needs it. As to the rear man, he can always find a place on his body against which he may rest his wrist, either against the ankles, the knee, the hip, the ribs or in extremely high positions, the head, thus directing the strain to his body, a mass not easily moved.

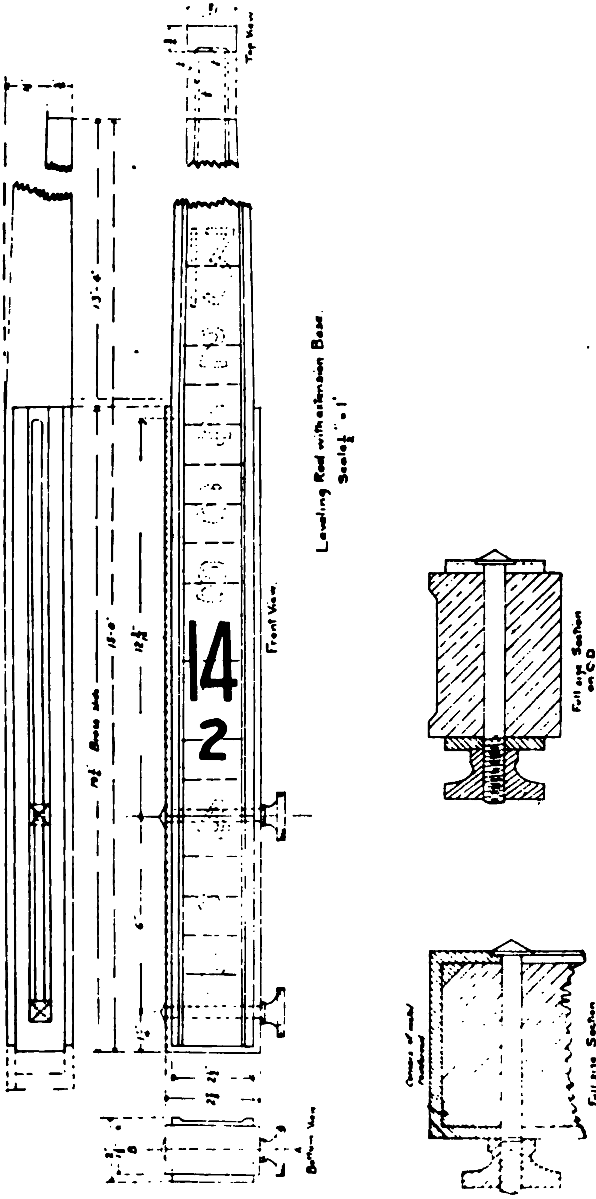
One other little instrument of the list remains to be spoken of. It is presumed that nearly every surveyor is familiar with the same. If not, one of the best labor-saving devices has been overlooked. The angle mirror, an instrument easily carried in the head chainman's pocket, is referred to. A crayon mark on a wall or an erect stone at each angle thereof; or in the case of a stream, a ranging pole at each bend, serves as a signal which enables the head chainman to take the distance to an offset thereto by means of the mirror. The steel tape may then be laid down and the cloth tape (sufficiently accurate for the purpose and less liable to injury) used for measuring the offset, the transitman lining in a finger held on the same, for the purpose.

It was the intention of the writer to continue this discussion into the province of the transitman, but consideration of the length of the foregoing and of the ability, not to say necessity, of the transitman to devise for himself, prompts him to refrain. If his object in writing the article,—the attainment of more efficiency in field work,—be attained, the writing is not in vain.

DESCRIPTION OF A "LEVELING ROD" USED BY THE METROPOLITAN WATER BOARD AT SPOT POND.

This rod was brought to the attention of the committee by Mr. Frank L. Clapp of Waterbury, Conn., who formerly used it in the work at Spot Pond. The credit for originating the rod was accorded to Mr. W. E. Foss, although Mr. Clapp worked out some of the details.

The rod, some drawings of which accompany this description, is fifteen feet long, and numbered from the top downward. In


Leveling Rod with extension Base.
Scale 1/2" = 1'

sections it tapers from 2¼ x 2⅛ inches at the base to 1¾ x ¾ inches at the top.

At the base is attached a brass shoe through which a three-quarter inch brass rod about twelve inches long slides into a slot in the rod. There is also a thumb screw and clamping device as shown in the drawings for holding the sliding brass rod in any described position.

The object of the rod is to decrease the mental labor of figuring elevations, and it is particularly adapted to cross-sectioning large areas, such as were stripped of loam and vegetable material at Spot Pond.

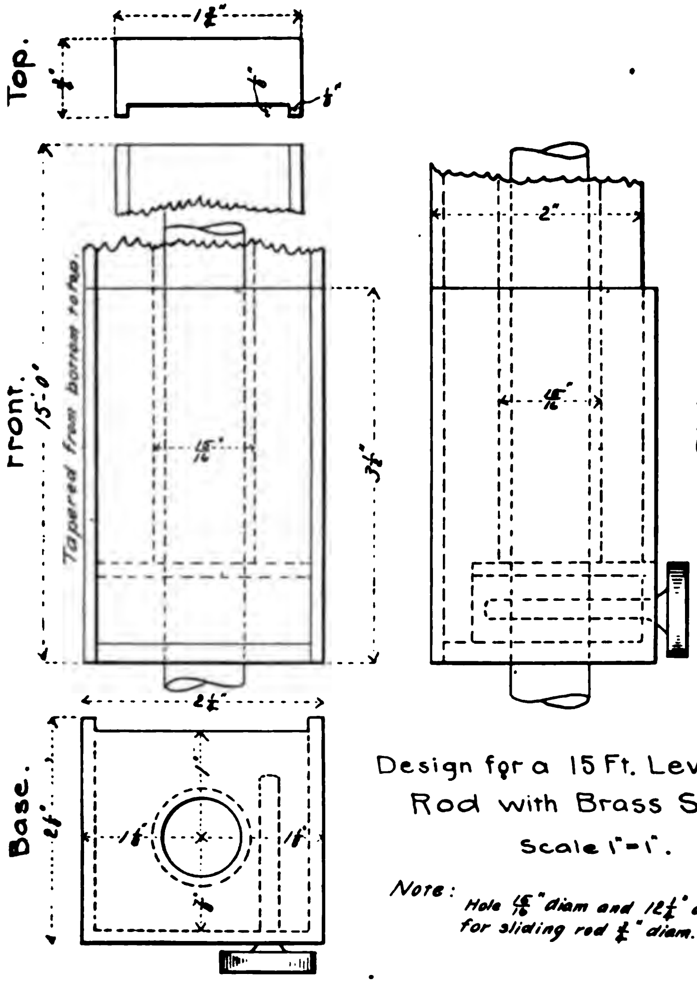
For the use of this rod bench marks should be first established with an ordinary rod, at convenient intervals of about ten or fifteen feet in elevation, over the ground to be cross-sectioned. As the method of using the rod can perhaps be most easily shown by an example, one will be assumed by way of illustration.

Suppose the bench mark to be elevation 76.23: set up the instrument preferably so as to read a little less than 6.23 on the rod [illegible] the ground permits.

This, however, is not essential. We will assume that the rod [illegible] until the hundredths [illegible] hundredths of the bench mark: [illegible] thumb-screw is tightened to hold [illegible]

[illegible] elevation of the bench mark [illegible] graduated and num- [illegible] evident that a reading of [illegible] feet below the bench [illegible] This elevation of [illegible] readings from this [illegible]

[illegible] elevation of 70 or at [illegible] at elevation [illegible] proceeds to hold [illegible] where the elevations are [illegible] what he actually [illegible] the reading [illegible] in the proper columns. [illegible] the notebook calls for [illegible] result [illegible]



Design for a 15 Ft. Leveling Rod with Brass Shoe.

Scale 1" = 1".

Note: Hole 15/16" diam and 12½" deep for sliding rod ⅞" diam. 12" long.

Where the distance from the instrument is great, the megaphone can be used to good advantage. In case the rod had been adjusted to read not 6.23 on the bench mark, but 8.23, the hundredths being always made to correspond with the hundredths of the bench mark, it is now evident that a reading of zero on the rod indicates an elevation 8.23 below the bench or in this case elevation 68.00.

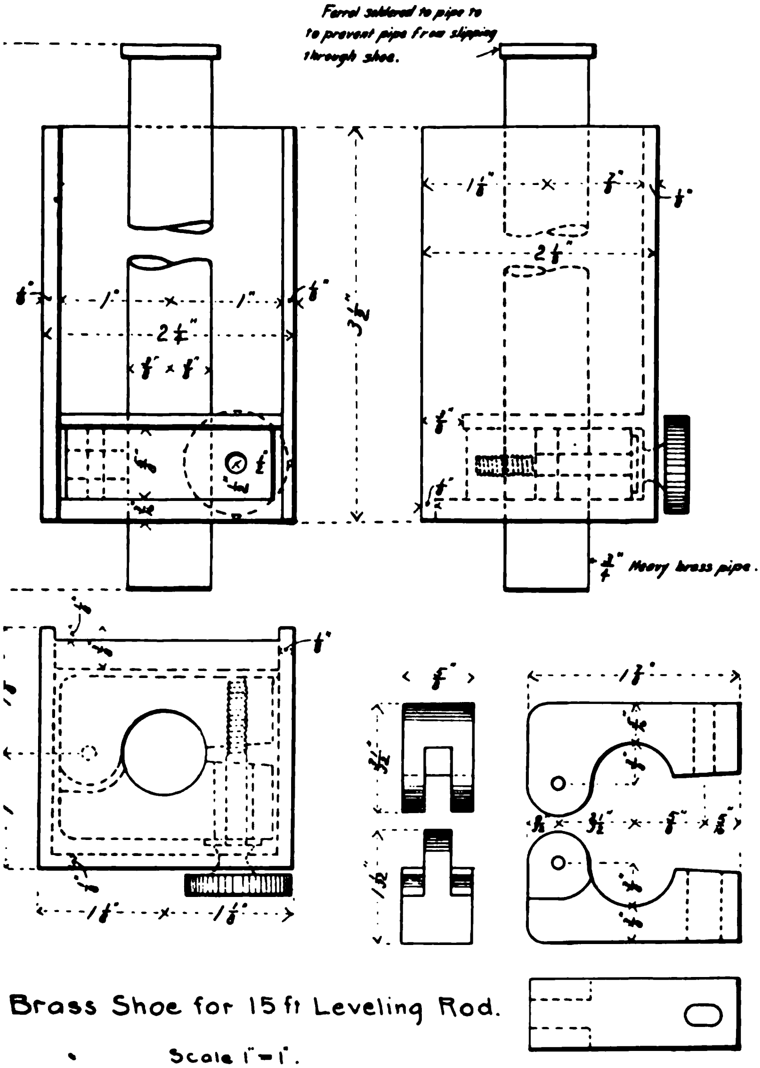
The recorder now mentally adds the rod readings to 68.00, which becomes the base for all readings taken at this height of instrument: a reading now, say of 5.60, would indicate an elevation of 5.60 feet above the base or 73.60.

One instance came before your Committee which the members of the Society might find of use (?) to them in case they are surveying for a law-suit.

A surveyor, about ninety years of age, was engaged by a certain Mr. A. to survey a boundary line, which consisted mainly of a stream or brook. The stream having changed its course at one place, had formed an island, and the timber had been removed by his esteemed friend and neighbor, Mr. B. Therefore the controversy.

The surveyor started out, and finding that the banks of the stream were so overgrown with underbrush and briers that he was afraid to venture in, he looked around and saw that a few rods away was a clear space. He set his instrument up and took the general course of the stream, and then, without taking another course or any distances at all, removed his instrument to the cleared space that he had noted a few rods away.

He there reset his instrument, and running a line by the course he had taken, when back at the stream, continued in that course and measured until he had arrived where he thought the stream reached the island. He then, without taking any other course or distances, removed his instrument to the head of the head of the island, and after taking the course from end to end, measured the length of the island, but did not measure the [illegible] any of the stumps of the trees which had been [illegible] on account of which the suit was brought. He then thought that he had all the data that was needed. The next day he brought his "minutes" to a draughtsman to plot. There were but few words spoken and a quick curtain. The draughts-


Ferrel soldered to pipe to to prevent pipe from slipping through shoe.
2 1/4"
1"
1"
3/4" Heavy brass pipe.

Brass Shoe for 15 ft Leveling Rod.

Scale 1" = 1".

man can swear to the above, but cannot tell how the law-suit was decided.

All of which is respectfully submitted,

(Signed) Frank W. Loomis, *Chairman,*
Harry E. Carlisle,
Courtland R. Darrow,
Committee on Field Work.

REPORT OF COMMITTEE ON ELECTRIC RAILROADS.

To the President and Members of the Connecticut Society of Civil Engineers:

Gentlemen:—Your Committee on Electric Railroads submit the following report:

We hoped to be able to make our report not only of interest to the members of the Society, but of some technical value, but have found ourselves hampered by the lack of interest among the members. It seems almost impossible for a committee to secure data from them—the three letters published as part of this report being the only notice taken of some twenty requests for information. Some justification of this seeming apathy may be found in the fact that the past year, in street railroad work, was [illegible] for the lack of anything interesting or unusual. Several [illegible] large magnitude are on paper, [illegible] has been but little.

[illegible] Springfield Street Railway has been completed [illegible] January 13th, 1902. [illegible] miles, and the construction [illegible] some culverts, etc.—the only [illegible] about 200 feet length [illegible] replaced by a steel bridge. [illegible] 30 ft. lengths— [illegible] covering the entire line, with [illegible] flexible bracket. Cars are [illegible] Springfield, and are of the double- [illegible]. They are equipped with [illegible] Christensen air-brake, with independent compressor. The power house receives conventional, but strictly up-to-date equipment. [illegible] 300 K.W. 550 volt direct current generators of General Electric manufacture are direct connected to cross-compound engines of the Wetherell Engine Co. These receive steam from two batteries of water-tube boilers of the Aultman Taylor Co., with a rated capacity of 750 h.p. The condensers are of the Knowles twin vertical type (jet). The Holly system is used to return all the water from drips, etc., to the boilers—which are fed by two duplex double-plunger pumps of Deane manufacture. There is a wooden car-barn with a capacity of 16 cars.

An installation which may be of interest to members, but does not come within the scope of your committee, is the power house of the Berkshire Street Railway Company at Pittsfield, Mass., now in course of construction and nearly completed. It is constructed to generate power for their line, which will run from Cheshire, Mass. to the Connecticut State Line near Ashley Falls—a distance of about 50 miles. This station is unique for railroad work in this part of the country, in that it generates a 3 phase current of 13,300 volts potential, which goes directly to the transmission line without the use of step-up transformers. This current will be generated by Westinghouse revolving-field alternators of 750 K.W. rated output, driven by cross-compound engines of 1200 h.p. A visit to this station, embodying as it does the highest form of modern electrical practice, would, no doubt, be interesting to any of our members.

The appended table, taken from the Report of the Railroad Commissioners for 1901, shows the additions made to track during that year.

INCREASE IN MILEAGE.

Bridgeport Traction Company	1.069	
Connecticut Lighting & Power Company (N. B. Dist.)	.688	
Connecticut Light & Power Company (Waterbury Dist.)	1.286	
Derby Street Railway Company	.004	
East Hartford & Glastonbury Street Railway Company	.755	
Fair Haven & Westville Street Railway Company	5.795	
Hartford Street Railway Company	11.085	
Meriden Electric Railroad Company	.100	
Norwalk Tramway Company	.283	
Norwich Street Railway Company	4.328	
People's Tramway Company	.199	
Stamford Street Railroad Company	1.720	
Winchester Avenue Railroad Company	.370	
Total increase		27.682

Decrease in Mileage.

Connecticut Lighting & Power Company (Norwalk Dist.)	.683	
Milford Street Railway Company	.069	
Hartford, Manchester & Rockville Tramway Company	.983	
New London Street Railway Company	.244	
Shelton Street Railway Company	.157	
Westport & Saugatuck Street Railway Company	.389	
West Shore Railway Company	3.900	
Total decrease		6.425
Net increase		21.257

There has been a decrease during the year in sidings of 5.153 miles.

J. L. Adams,
C. B. Snell,
William Sperry,
Committee.

In reply to yours of the 17th instant, requesting facts pertaining to paving as related to street railway construction in our city, I would respectfully submit the following general facts, in the absence of more definite information as to your requirements.

Our modern permanent pavements have, up to this time, consisted of wood blocks, vitrified brick and sheet asphalt, and the only one of these which is not laid complete from curb to curb in streets having railway tracks is sheet asphalt. In its place vitrified brick is used between rails and 18″ outside thereof.

We demand the substitution of full grooved for ordinary T rails, the most common section being the Trilby 9″ girder rail, and it seems to meet with the approval of the vehicle traveling public as well as the railway company. The chief objection to it is the width of exposed steel, and my judgment would demand its being narrowed, at least ½ and possibly ¾ of an inch.

Concrete 6″ in thickness and sand cushions 1 or 1½″ in depth are ordinarily adopted. In grading for concrete base, that portion of sub-grade below the rails and between ties, for a width of about one foot, is excavated to the bottom of tie, and as the rail base is imbedded in the concrete to a depth of 3 or 4 inches, it is expected that at such time as the ties shall decay, the rails will be properly supported.

On new construction, I would recommend a less frequent use of ties and the adoption of beams of concrete in lengths of 6 or 8 feet, 10 inches in depth under rail bases and 15 inches wide, with a proper rail fastener imbedded therein. The use of sufficient tie rods, the top of which should not be above the top of concrete base, is of course insisted upon. Rails 60 feet long and joint boxes to admit of tightening bolts would be improvements.

Portland cement concrete is none too good for this work, and its present price enables its use at but slightly if any greater cost over natural cement concrete when the bulk of aggregate which can be used is considered.

It might interest you to know that in 1899 and 1900 we applied the so-called Buckland device to a considerable length of track made up of tram head rail, thereby converting it into a full grooved section, and that with the exception of asphalt, the city of Springfield does all its paving by day labor.

Until the fall of 1898, we collected from the railway company for the cost of paving between rails and 18″ outside thereof, in accordance with terms of franchises or locations; but since that date, state legislation gives to the city an excise tax which is collected from the railway company, based upon the lengths of tracks within city limits, and gross receipts per mile of track, which is supposed to reimburse us for the cost of paving between rails and 18″ outside thereof, maintenance of street surfaces adjacent to tracks, removal of snow between curbs, etc., all of which expenses would otherwise be borne by them. It is shown by experience that this amount is hardly adequate.

Further information will be cheerfully furnished upon request.

A. A. Adams.

Springfield, Mass.

In answer to your circular from the Committee on Electric Railroads, I would say that there has been no addition or extension of any of the electric railways in this vicinity. Changes and improvements in management and repairs I have no knowledge of. The Electric Railroad Company in this place always pay their proportion of any of the improved forms of pavement. This includes macadam pavement, and during the year past a macadam pavement was placed on one of our principal streets, on which is located a single track with turnouts; the total cost of street being about $7,300, and the railroad company's portion $1,700. In proportioning the amount to the railroad company, the total cost of construction between curbs per square yard is taken and the railroad company pay for one square yard per lineal foot of single track (turnouts additional). This applies also to asphalt, brick or granite block paving. Have placed one small block of asphalt paving the past year, on which there was no track.

W. S. Clark.

Meriden, Conn.

P. S.—The city does all of the work of construction on the pavement; the railroad company aligning and surfacing their track for the reception of the pavement.

I have not gone into detail in the following résume of my past year's work, as I do not think you care for the same since I have had no very unusual features.

During the past year we have been obliged to resurface, and in small degree retie, many miles of track in the center of the city owing to the city's laying brick pavements, to fit which the grade and in some cases the line had to be changed. Owing to the rails being surface-bent at many of the joints, we were obliged to do quite a little iron shimming after the concrete was put in place. Alongside of the Green on Chapel street two tracks were removed and the remaining two placed in the center of the street.

Wherever pavements were laid, if the rails were not in first class condition, new 6″ tee rails were laid. Much new special work has been put in, practically all of guarantee construction. Our single track to the Momauguin shore has been double tracked from Granniss corner, with the exception of half a mile across the meadows, which has been filled in during the present winter, and the iron will be laid in the early spring.

We are at present buying rights of way for the proposed road to Derby, upon which we expect to start work immediately. On this line we shall leave the highway wherever practicable.

The country is very rough, and in some places cuts and fills of twenty-four feet are encountered, many of the cuts being in rock. We avoid two highway crossings by going under the first and over the second, and have been able to eliminate many bad curves.

We intend to use eighty pound rails in 60 ft. lengths, with split switches for necessary crossovers.

J. K. PUNDERFORD.

New Haven, Conn.

REPORT OF COMMITTEE ON BRIDGES AND STEEL CONSTRUCTION.

To the President and Members of the Connecticut Society of Civil Engineers:

GENTLEMEN:—Your Committee on Bridges and Steel Construction for the year 1901 respectfully submit the following report:

There has been considerable bridge and structural work within the State during the year, yet this committee has been unable to learn of any work of unusual magnitude, or of special engineering interest.

The bridge construction in the State naturally divides itself into two quite distinct classes: that which is built by the cities or towns, and that built by the railroads and other corporations.

In the first mentioned class, there has been more than usual activity during the past year; in fact there are few towns of any size that have not done some bridge work, or else contemplate some for the coming year. Throughout the smaller cities and towns there has been a noticeable increase in the demand for modern and more permanent structures for small bridges, and a general tendency toward spending more money for new, and less for repairing old structures.

A large percentage of this class of bridges is rather insignificant when considered individually and furnish very little work for the engineer.

Of the one hundred and twenty-six bridges of this class built this past year, one hundred and ten were small I beams or plate girders ranging from 8 to 18 feet in length; seven were less than 50 feet long, four were between 50 and 80 feet long, and for the remaining five we were unable to obtain dimensions.

The one hundred and ten small bridges were about evenly distributed over the State, while the larger bridges were located as follows: Winsted, four; Torrington, two; while Waterbury, Bridgeport, Mansfield, Danielson, Guilford, Pomfret, South Windsor, Somers, Eastford and Plymouth each had one.

At the Insane Hospital in Middletown, about twelve hundred lineal feet of bridging has been erected to connect the buildings. This was for nine-foot passageways and cost about $25,000.

In addition to the bridges built within the boundaries of this State, members of this Society have furnished plans for, and supervised the erection of, many bridges in other states.

Of that class of bridges built by private corporations, the greatest number has been built by the New York, New Haven and Hartford Railroad Company.

During the year, this company has built twenty new steel bridges, four wooden trusses, two new pile trestles, and one brick arch within this State.

Of the twenty new steel bridges, three were to carry highways over their tracks, of which two were to eliminate grade crossings and one was to renew an old bridge.

The remaining seventeen are all railroad bridges of the plate girder type, fifteen of which were built to replace old structures that were unable to meet the demands of modern rolling stock, one was to abolish a grade crossing and one was necessitated by a change in street width.

One of the four wooden trusses was a new Howe truss designed to carry heavy traffic and replaced an old bridge of similar type. This was tried as an experiment at a time when steel was abnormally high and delivery very uncertain, but was found to be no great saving in cost even under those conditions.

Of the three remaining wooden trusses, two were renewals of old King Post trusses on a branch line and one a new highway bridge.

One of the new pile trestles replaces an old Howe truss that had outlived its usefulness, while the other is an entirely new structure.

The brick arch has a clear opening of ten feet with stone bench walls and replaces an old arch of six feet clear span, which had insufficient waterway.

In addition to the new work mentioned above, this company has strengthened one Howe truss, one large iron draw span and four small iron bridges, beside reinforcing about thirty wooden stringers and trestles.

The Central Vermont Railway has built eight new bridges, two of which are riveted trusses 148′ 8″ long, one an I beam span of 28′ 6″, and the remainder plate girders, ranging from 52 to 96 feet in length.

We understand that these are all railroad bridges, and replace old structures.

The Central New England Railway built a four-span railroad viaduct at Lakeville to replace an old Howe truss bridge. This structure is about 160 feet long and cost about $5,000.

This company also built a half-through plate girder bridge 105 feet long at Hartford to carry Sigourney street over its tracks. This is a fifty-foot street with girders thirty-two feet on centers and nine-foot walks on brackets. The floor beams and stringers are steel and the flooring consists of two layers of 3″ plank and a wearing surface of 2″ plank. The total cost of this structure, including masonry, was $9,071.74.

Of other bridges built by corporations, there has not been anything of importance brought to our notice.

There have been a few minor structures for electric roads, two or three pipe bridges, etc.

A résume of the railroad work within the State shows that of the thirty-one bridges erected during the year, twenty-eight, or a little over 90 per cent., were to renew structures which were presumably unable to carry the heavy rolling stock now in use; while practically all of the reinforcing and strengthening of old bridges mentioned above was for the same reason.

Considering the above facts, it may not be out of place to say a few words in a general way regarding the life of the old bridges taken out, and the actual loads which railroad bridges in this State are called upon to carry.

Several of these bridges were Howe trusses, which had given remarkably good service for many years, and reflect great credit upon their builders, who in many cases had not the advantages of a technical education.

The iron bridges were practically all less than twenty years of age, while some of them had seen barely fifteen years of service. Undoubtedly these bridges were expected by their designers to have lasted for a much longer period. but the increase in weight of the rolling stock has far exceeded the expectations of the most far-sighted.

While in the design of railroad bridges, engineers have always endeavored to make ample provision for the future. there are probably few bridges in this State over fifteen years of age capable of carrying the heaviest modern locomotives with the factor of safety demanded by good practice.

The largest locomotives in use in this State, while modern in every sense of the word. are not as heavy as those found in other sections of the country. where transportation conditions are different.

The following diagrams are fairly representative of the engines in actual use in this State at the present time.

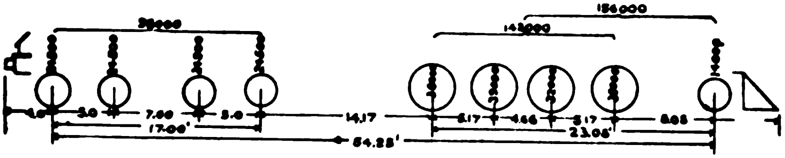
The increase in the carrying capacity of cars during the last decade is worthy of notice. Ten years ago few freight cars had a capacity of over 40,000 lbs.. while there were none in regular service of more than 60,000 lbs. capacity. Now, new cars of less than 60,000 lbs. capacity are the exception. while 80,000 lbs. and 100,000 lbs. capacity cars are daily used throughout the country. and cars of modern steel construction are capable of carrying 110,000 lbs. or more.

These loads added to the weight of the car, which is approximately from 33 to 40 per cent. of its capacity, are more severe upon our bridges than many of the locomotives in use ten years ago.

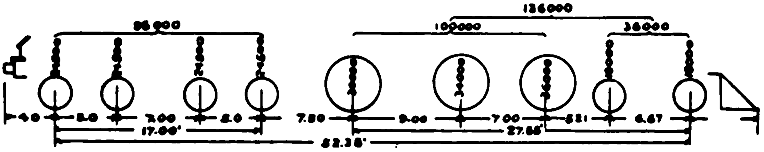
What the future will bring we will not venture to predict. The largest railroad in this State issued new standard bridge specifications during 1901. in which the loading was increased, and if the past be any criterion for the future, it is certainly a wise move.

In regard to the building and structural work within the State. we regret to say that through a misunderstanding among our committee we are unable to offer any definite information. We can only say that there has undoubtedly been as much work of this class as in previous years.

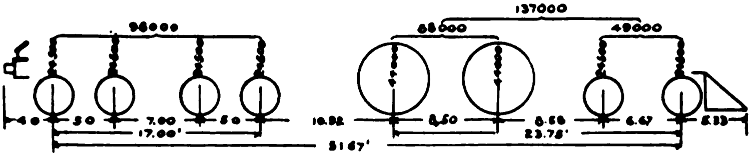
The outlook for the coming year is exceptionally bright in all lines of construction and especially in this branch.



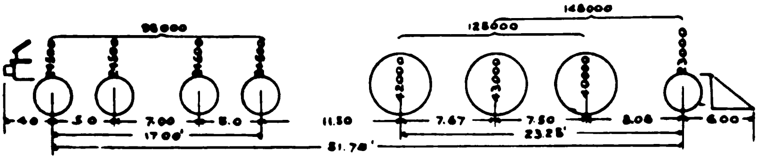
Consolidated Engine.



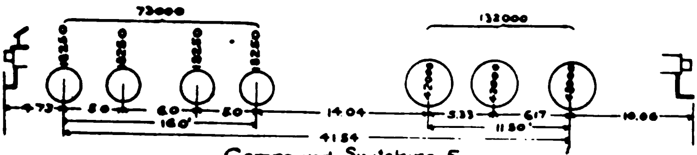
Ten Wheeler.



8 Wheel Passenger Engine.



Mogul Engine.



Compound Switching Engine

Next year will mark the commencement of, and undoubtedly see work well advanced upon, one of the largest pieces of bridge construction ever undertaken within this State.

We refer to the work in connection with the abolition of grade-crossings on the line of the N. Y., N. H. & H. R. R. at Bridgeport, Conn.

There will be a steel viaduct 3,265 feet long on the main line, carrying not less than four tracks at any point and for a greater portion of its length there will be five and six tracks.

On the Berkshire Division, which leaves the main line at this point, there will be a single track viaduct 1,420 feet long.

There is to be a rolling lift drawbridge of the well known Scherzer type over the Pequonnock River. This bridge is already contracted for, and will be the first of its kind in the State.

There will also be several plate girder bridges over the streets in East Bridgeport, where the elevated tracks will be carried on an earth fill between retaining walls.

ERNEST W. WIGGIN.

PARTIAL LIST OF BRIDGES CONSTRUCTED DURING 1901.

RAILROAD BRIDGES.

ailroad Co.	Style of Bridge.	No. of Spans.	Total Length.	No. of Tracks.	Remarks.
. N. H. & H.	Deck plate girders	4	176′ 0″	2	Replaces Howe trusses and iron girders.
"	" "	3	128′ 6″	1	Replaces old iron girders.
"	" "	2	72′ 6″	1	" " trusses.
"	" "	2	....	1	" old Howe truss.
"	" "	1	abt. 25′	1	" trussed stringers.
"	" "	1	26′ 2½″	1	2 track bridge, only 1 track rebuilt.
"	" "	1	23′ 0″	1	Replaces wood stringers.
"	" "	1	23′ 4″	1	" old iron girders.
"	" "	1	32′ 8″	1	" " "
"	" "	1	27′ 0″	1	Renewal.
"	" "	1	25′ 0″	1	"
"	" "	1	67′ 6″	1	Replaces Howe truss.
"	" "	1	45′ 0″	4	Caused by change in street width.
"	" "	1	56′ 6″	1	Renewal.
"	½ thro' plate girders ..	1	68′ 9″	2	Replaces Howe truss.
"	½ " " ..	1	80′ 3″	2	" "
"	½ " " ..	1	34′ 4″	3	Elimination of grade crossing.
"	Wooden Howe truss...	1	47′ 8″	1	Renewal.
"	" King post truss	1	36′ 3″	1	"
"	" " "	1	36′ 3″	1	"
"	Pile trestle............	..	89′ 0″	1	Replaces old Howe truss.
"	"	..	....	1	
"	Brick arch............	1	10′ 0″ clear	1	
al Vt. Ry. ..	Thro' riveted truss	1	148′ 8″	..	
"	" " "	1	148′ 8″	..	
"	½ thro' plate girders ..	..	96′ 0″	..	
"	½ " " " ..	..	67′ 8″	..	
"	½ " " "	..	65′ 8″	..	
"	Deck plate girders	..	61′ 4″	..	
"	" "	..	52′ 0″	..	
"	I beams	..	28′ 6″	..	
al N. E. Ry.	Deck pl. girder viaduct	4	160′ 0″	..	Replaces a 2 span Howe truss bridge, cost abt. $5,000.

HIGHWAY BRIDGES.

Location.	Style of Bridge.	No. of Spans.	Total Length.	Width.	Remarks.
Hartford	½ thro' plate girders.	....	105' 0"	50' 0"	Sigourney st., C. N. cost $9,071.74.
Winsted	....	1	45'	24' 0"	Monroe street.
"	....	1	40' 0"	24' 0"	Meadow street.
"	....	1	....	....	Main street.
"	....	1	....	....	Main street.
Torrington	Plate girder	1	30' 0"	....	Pearl street.
"	"	1	30' 0"	....	Main street.
Waterbury	....	....	....	....	Meriden Road.
Mansfield	....	1(?)	75' 0"	14' 0"	
Guilford	....	1	....	....	Over West River.
Danielson	I beam bridge	1	28'	20'	
Pomfret	I " "	1	30' 0"	20'	
Eastford	Pony Pratt bridge	1	50' 0"	12'	
South Windsor	....	....	80' 0"	18'	
Somers	....	1	27' 6" (?)	12 (?)	
Plymouth	....	1	53' 0"	16' 0"	
Thompson	½ thro' plate girder	1	84' 6"	....	N. Y., N. H. & H. R elimination grade c
"	½ " " "	1	48' 3"	....	N. Y., N. H. & H. R elimination grade c
....	Wooden bridge	1	....	....	N. Y., N. H. & H. R
Bridgeport	Drawbridge	....	....	....	Stratford av., not com
Danbury	15" I beams	1	35' 0" clear	20' 0"	Masonry let for $1,561. perstructure built b
....	12" I "	1	18'	20'	Masonry let for $955 structure built by t
....	15" I "	1	29' 0"	20'	Masonry let for $245 structure built by t
....	12" I "	1	18'	20'	Cost $400.
....	Timber stringers	1	20' 0"	20' 0"	Total cost $700, in masonry.
....	" "	1	18'	18'	Cost $200.
....	" "	1	16'	20'	Cost $215.
....	" "	1	18'	20'	Cost $205.

REPORT OF COMMITTEE ON HIGHWAY CONSTRUCTION.

To the President and Members of the Connecticut Society of Civil Engineers:

GENTLEMEN:—The matter of highway construction is fast becoming the subject of more thought and care each year, as every city and town has come to recognize that good roads are an important factor in all municipal and state affairs. The expenditures for improving our highways are greater every succeeding year, showing that the people, in general, consider highway improvement a good investment.

At the last session of the General Assembly, there was appropriated, for the improvement of public roads for two years, the sum of four hundred and fifty thousand ($450,000) dollars, showing an increase of one hundred thousand ($100,000) dollars over the last appropriation. This, in itself, is a point gained for good roads and shows with what favor they are considered. The statutes for improvement of public roads were changed, in a few respects, by the last General Assembly, but are, in the main, the same as formerly.

Every town in the State, with but few exceptions, has taken advantage of the State appropriation, for they all realize its helpfulness and importance, in securing for them good highways at a moderate cost. Sufficient applications were received, I believe, last fall to exhaust the entire appropriation. Many of the towns started work last fall, under the 1901 appropriation, and while a few finished their work, the majority will not do so until this spring or summer.

One fact, noticeable lately, in connection with this movement of improving highways, is the large number of claims for damages, on account of changes of grade made in the prosecution of this work. Very few of our town highways have ever been graded properly, but are mostly according to the original contour of the land; so that in most cases of highway improvement, a change of grade is important and necessary for various reasons, such as to get a uniform grade of least resistance and also a grade that will drain the road properly. If the authorities of our towns and cities, where changes of grade are made which are likely to damage abutting property in any respect, would look up this matter before any change is made, probably the abutting property owners would not bring so many suits for damages afterwards. A large amount of money would thus be saved the authorities, which could be used to advantage in highway improvement. And our highway work would be rid of a disagreeable factor. This result can only be accomplished by first securing a waiver of all damages from abutting property owners, before the work is begun, or by making an assessment of benefits and damages to abutting property owners. No matter what the changes in grade, one of these methods should be pursued, for in this way, and this way only, are we secure from the odious damage claims which are becoming so numerous.

One of our members complains to the chairman of the Committee on Highway Construction that "land lines, mere stones, street and town lines, established by courts and agreement years ago, are being removed by surveyors regardless of the law." If this is so, I hope it is not done by any member of this organization, for I consider it a very unprofessional as well as a lawless act. It is the duty of every engineer and surveyor to do everything possible towards the preservation of such marks, as they are convenient and advantageous as well as necessary in our line of work.

From another source, I understand that the selectmen of some towns strenuously oppose any material changes in grade of the roads to be improved. To this, I would say that, although it may be an improvement to have a road macadamized without change of grade, I do not consider it a permanent and well-made improvement, unless the road is first graded to a proper and official grade, no matter what change is called for; but, if by making the change, there is liability of damage claims, this difficulty can be easily overcome by the legal and business-like methods spoken of above.

The Highway Commissioner very wisely insists on a practicable grade for the roads to be macadamized before accepting the plans and granting the appropriation; and this action is commendable as well as desirable.

No city government would ever think of paving or macadamizing a street until a suitable and regularly adopted grade had been established, and it should be so with every highway that is to be improved, whether by city, town or otherwise.

The matter of highway improvement is here to stay and should be carefully pondered over and supported by every engineer. For with good roads all over the State first, the rest will follow. Connecticut is, I believe, the banner state in the "Good Roads Movement," and it is our hope that this work, now thoroughly commenced, will continue, until every highway in the State is improved, and we can point to Connecticut as the banner state for its good roads.

In an appended table will be found the highway construction for 1901 as reported to this committee.

Respectfully submitted in behalf of the Committee,

F. H. OLDERSHAW, C.E., *Chairman.*

HIGHWAY CONSTRUCTION.

City or Town.	[illegible]	Width.	Kind and Depth.	Contract Price.	Cost if done by Day Labor.	Average Grading.	Remarks.
Bristol	[illegible]	16'	Telford Macadam, 16'				State Road.
"	2,000	16'	Macadam, 7''				"
Danbury	2,000	42 [illegible]'	" 8''		$2.19 per ft.	$1,123.25	Cost includes corner curb, etc. } City Work.
"	1,110	36'	" 8''		2.30 "	394.97	" " "
"	415	56'	" 8''		2.03 "	146.20	" " "
"	7,500	22'	Grading	$3,200 total cost		9,700 cu. yds.	600 yds. rock and $700 for new bridge.
"	4,000	16'	Macadam, 7''			4,000 "	State Road—1901, 1902 appropriations.
"	6,500	22'	Grading	$0.15 per ft.		Average	" nearly completed.
"	7,420	22'	"	0.268 "		Heavy	" " "
"	1,250	22'	"	1.22 "		Very heavy	" includes cost of bridge.
"	[illegible]	16'	Macadam, 7''	1.19 "		Light	" 730 ft. is Telford.
"	2,960	16'	" 7''	0.70 "		Average	" not completed.
"	2,200	16'	" 7''			Light	" " "
"	2,517	16'	" 7''	$0.71 per ft.		Heavy	" all completed.
"	27,620						" surveys just made.
Middletown	1,550	12'	Macadam, 7''	$1.04 per ft.		Light	" not completed.
"	1,403	12'	Telford, 12''	1.24 "		Light	" " "
New Britain	1,000	16'	Macadam, 7''		$1.00 per ft	Light	City Work.
"	5,000	30'	Grading			Very heavy	"
"	3,000	16'	Macadam			Average	State Road—survey just made.
Norfolk	2,500	16'	Gravel			5,000 yards	"
Plymouth	2,100	50'					Not commenced.
"	2,400	60'					Not finished.
Plainville	5,050	16''	Macadam, 7''	$0.89 per ft.		Average	State Road.
Stamford	4,405	16'	" 7''	1.07¼ "		4	"
Waterbury	3,443	15' to 20'	" 6''	0.65 per sq. yd.		5% of cost	"
Yalesville	1,000	18'	" 7''		$1.00 per ft.	400 sq. yds.	Town Road.

REPORT OF COMMITTEE ON OFFICE MANAGEMENT.

To the President and Members of the Connecticut Society of Civil Engineers:

GENTLEMEN:—The Committee on Office Management beg leave to submit the following report:

An old lady who carefully read the dictionary through, from cover to cover, reported that "It was good reading, but seemed a little disconnected."

With the thought in mind of presenting a somewhat "disconnected" report, in other words, to obtain the experiences and suggestions of as many of our members as possible, in relation to anything connected with the arrangement and management of engineering work, either in the office or in the field, this Committee mailed to each member of the Society a postal card containing the following earnest plea for assistance in its work:

"*Dear Sir:*—We are preparing our report for the 'Annual Proceedings' of the Society, and earnestly request your coöperation in the work.

We want to make this report an exchange of ideas and suggestions and urge that you give our request more than a passing notice.

Send us something, long or short, out of your experience, in relation to the arrangement or management of work in the office or the field.

Something you have tried and found satisfactory, perhaps otherwise.

Some little knack, an old story to you, may be new to others.

Don't hesitate because you can say but little, and remember that a prompt response will simplify our work."

That the response was not more general is largely due to the excessive modesty of our members.

While all must experience many things in common, each one faces the work from a slightly different angle and so obtains a view-point which is all his own.

Realizing this, it is evident that the ideas and experiences of the individual must be of interest and advantage to all. Without the hearty coöperation of the members generally, this committee must find the preparation of a report much like the ancient problem of "making bricks without straw," and while we sincerely thank the members who so kindly responded to our request, we regret that that response was less than something from each member of the Society.

Respectfully submitted,
THEODORE IRVING COE,
JOHN T. HENDERSON,
BENJAMIN F. HATHAWAY,
Committee on Office Management.

My little experience of late years has been mostly in surveying wood lots.

In the Pine Tree State some surveyors may often, like myself, not be able to get out of the woods.

If I were talking to a young surveyor who had his first long line to run between points separated by dense woods, and perhaps swamp, I would tell him to avoid the mistake I have made in the past years of taking too much time and pains in starting.

My own experience has taught me that to point your telescope the way you would walk without deliberation, makes the best trial of time and patience—a great item anywhere.

I have known good surveyors who have thrown rockets at night, etc., to get a start, when a quick guess would have served better. I have guessed, and usually nearer than the rockets, or presumed calculation.

I do not believe in guessing only for the first trial: but after I have connected my points, then I make my accurate calculations.

Better calculate then, than before.

This is the best advice of an old-timer (whose locks are grey and little of any on the top of his head) to a young surveyor, who wants to get out of the woods, as I have often desired.

This suggestion I have found practical in long lot lines—town lines—or for any straight line, five miles or less between two points separated by obstacles.

I run straight if I can, and if not, I do the next best.

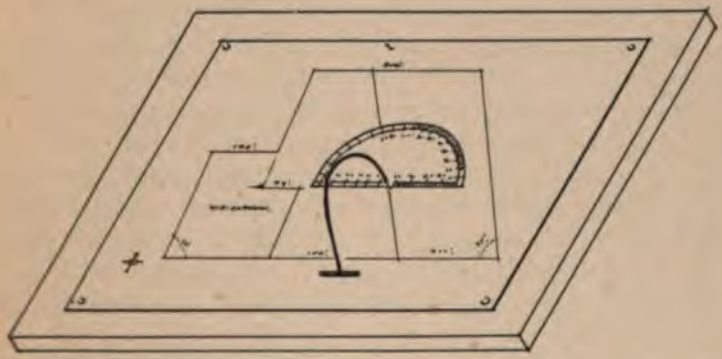
This may seem nothing to you city engineers, but I do not now have any special work in any city, and I have given what immediately occurs to me out of my recent years experience.

EDWARD C. HAYNES.

Center Lebanon, Maine.

To any engineer who has plotted surveys combining the use of angles and distances, the disadvantage of being obliged to use first protractor and then scale, is apparent. In the survey work of the City Engineer's office of Hartford, polar coördinates are much used where extreme accuracy is not required, and to facilitate the mapping of such surveys, I have arranged a combined protractor and scale that is both simple and effective.

The essential part is made by cutting an ordinary bristol board protractor exactly in half, preferably with a machine such as all bookbinders have. The scale is then graduated along the diameter with a right line pen. By placing a paper scale against this edge so that its surface is flush with that of the protractor, sufficient accuracy is readily obtained. After a little practice, it is quite easy to graduate a "40" scale with very satisfactory results.



After completing the scale, it is only necessary to cut a small depression in the board, under the center, and half through from the back, and gum a thin piece of celluloid into it. The celluloid should project beyond the edge enough to form the "V"-shaped notch, which is cut at the center to receive the needle, about which the protractor revolves.

The needle forming the pivot may be held in its vertical position in a number of ways. The device shown in sketch is made of brass tubing, filled with lead just over the center, which adds much to its stability.

C. M. GALLUP.

Hartford, Conn.

To your request for hints and ideas regarding office management, would say that we have a very complete system, which we have worked up to suit our particular business, and which is better than anything we have ever seen, for our particular use. It would require considerable space to fully explain it, but any of the members who could call upon us could see the practical workings of the system in a very few minutes.

We make use of the card index and the numerical system of indexing.

For filing circulars, price lists, etc., which are usually about as troublesome as any one branch of office helps to keep track of, it is as follows: We buy the common pasteboard letter files, costing 25 cents each, and remove the index, leaving an open box. In this we place our circulars, etc., in the order they are received, without regard to the subject-matter, numbering each in the upper right hand corner with the next higher number than the last one filed. Before placing in the file we enter upon a card (using for this the cards furnished by the Library Bureau) the name of the party furnishing the catalogue or circular, and below on the card giving the materials which are described in the catalogue, or at least the more important ones, and putting at the end of the description the number of the catalogue. We then take another card and enter on it the leading subject mentioned in the catalogue, below this giving the name of the party issuing the catalogue and, as before, the number after it. We take as many cards for this catalogue as there are leading things mentioned in it, of things that we think we should ever need to look for. This cross-referencing can be carried to as fine details as the use of the maker of the index [illegible] his business demands, the object to be gained being [illegible] that you will find the catalogue you want by [illegible] the first heading that comes into your mind as describing the matter [illegible] looking for.

The cards are filed in a cabinet made for that purpose, and [illegible] alphabetical order with projecting headings to [illegible] particular word.

[illegible] full, and for various reasons [illegible] space in the file so that there may [illegible] a new file, and place on the back the numbers representing the first and last circular in that file.

As we accumulate catalogues relating to the same subjects, we place the names of the different makers on the same card headed by that subject, always keeping a separate card for the name of each maker of a catalogue.

We also place on the cards under their proper headings the prices of any particular kind of material or piece of work that may prove of interest in estimating, especially if this price is of something that cannot be found in catalogues, but has come to us by experience or special interview with some party.

We have used this system for over five years now, and have something over 1,700 distinctly numbered catalogues, etc., and we find it extremely valuable to us.

When we get a new catalogue taking the place of an old one, we give the new one the same number as the old, put it in its place and throw the old one away. When we get a catalogue from a party, and it differs but very little from one we already have from the same party, but for any reason we do not wish to throw the old one away, we give the new one the same number, and after it place the decimal number 1, and file it right after the first one, so that they will come together. This method can be used to keep any number of catalogues relating to the same subject together, but does not work so well in practice unless for a few special cases as I have said above.

As illustrating the use of the above, we copy a few of our cards as they stand to-day in our file, taking the "G's" as they come.

GABEL MANUFACTURING CO.,
105 Market St., Pittsburg, Pa.

Instantaneous Water Heaters, 1512

Galvanized Iron.

Weight of for different gauges, Table, See $\underset{78}{1099}$
Price per pound and per foot, " $\underset{73}{1099}$
" of Conductors, " $\underset{80}{1099}$
" " Gutters, " $\underset{82-87}{1099}$

Galt & Sons, John.
New York.

Slate 499.

Gas.

Safety Gas Cock Co., 104.
Gilbert A Barker Manfg. Co., 105.
I. P. Frink, 116.
McKenney & Waterbury, 624.
Terrills Gas Machine Co., 107, 107.1

Gas Fixtures,

See Fixtures, Gas.

We might explain that on the card "Galv. Iron," where one number is used over another, the top figure is for the number of the catalogue, and the lower figure is the page in that catalogue. This is a system of reference that comes in handy very often.

There are many other devices we have equally helpful, but we will not take up any more of your space at this time, and trust the above may prove of help to some of our members.

CURTIS & JOHNSON.

Hartford, Conn.

My experience has been that a clear set of notes which could be [illegible] is about as valuable a piece of office [illegible] the past few years I have [illegible] work done by myself since [illegible] taken up and secured [illegible] access to these note books. [illegible] work where dates. [illegible] determine comparative [illegible]

HENRY W. AYERS.

[illegible]

[illegible] work done in an office: [illegible] the limit is confined to such [illegible] similar to their class, but under [illegible] the scope is so extensive that the task [illegible] their inscriptions to the limits [illegible] experiences meet with conceptions and obser- [illegible] may justify his suggestions.

We presume that all civil engineers recognize that close specific facts based upon fixed points constitute the means for a valuable record.

Any corporation issuing an order to a subordinate officer or servant, makes the corporation responsible for its effects, and consequently there should be convenient equipment by which the surveyor can conveniently record all his work, and as conveniently and precisely *restore any grade or other work which may concern himself, the citizen or corporation.*

This equipment requires a system of bench marks so placed that every point where grades are needed, such point can conveniently be compared with the recorded elevation of the bench mark.

If the above propositions are considered worthy, I will try to enunciate another: and that is that a good reliable standard map *or system of maps is necessary for the people and corporation of any city, borough or town*, and the true way to get such a map is by contract and not by subscription.

Contracts can define and contracts should define explicitly *just what items of fact are required* and just what degree of accuracy is expected; what bond, what forfeit, including terms and conditions of payment.

Having laid down, albeit but briefly, what I would attain, I shall offer my personal views respecting the method or methods relative to prosecuting the work, and right here all will recognize the one fact that in any movement looking towards this attainment, the first *must be an appropriation.* I shall make no assignments respecting amounts needed, and fortunately no estimates are here needed, for the work in all localities can commence on a small basis and be promoted according to the means and efficiency of the council immediately concerned. Having secured an appropriation to commence with, order two record books, one for *plain diagrams,* the other for *bench marks and topography,* or the whole work can be combined in one book if deemed advisable.

My books were made to order from cross section paper 10 x 10 to one inch. As the paper was prepared in rolls 20 inches wide, I ordered the leaves cut 10" by about 17½". The other book was of equal size and composed of No. 267 Keuffel & Esser Co.'s standard profile tracing paper; book No. 1 for diagrams, No. 2 for topographical delineation. Each book is provided with an index competent to accommodate the book's capacity. For No. 1 I have printed headings, thus:

Name of street, section, page. For the book No. 2, I have *Index to bench marks*, No., elevation, street name, page. Every bench is given a number and elevation, and also location.

I chose these rather than plain tracing sheets because I am accustomed to test, compute and plot my work by rectangular surveying. My plain diagrams are all based and located by the horizontal lines for latitude, by the perpendicular line for longitude or departure.

My bench marks are based, as is usual, upon an imaginary plane, located in the earth, at least as low as the lowest point within the surface of the territory which I wish to embrace in my canvass. There would be little use to specify principles which should govern. When invited to commence a *canvass of* [illegible] that must rest with the judgment of the person undertaking the work, coupled, perhaps, with the conditions of those parties who control the finance as well also the immediate needs of the people. I may say, however, that it is practicable [illegible] the territory assigned for a canvass. [illegible] suggest that in assigning latitude [illegible] the degree high enough to carry the [illegible] contemplated in the canvass. [illegible] departure.

[illegible] of bench marks is a [illegible] of fence [illegible] block— [illegible] *present*

[illegible]

[illegible] A man [illegible] was then called [illegible] I then [illegible] thus [illegible] I went [illegible] to Windsor and explained the matter to him and asked to see his minutes of the survey. His answer and advice did me good. He said, "I don't keep minutes; and now young man, you are just starting in the business, and my advice is, that if a man don't think enough of his boundaries to keep them up after I have set them for him, I want another job." I have followed that advice since. It cost that man two days' work for surveying and examining boundaries of the adjoining property to find his lands.

A. D. McLean.

Wallingford, Conn.

Experience in a Swamp.

This is not anything new in surveying; but a statement of facts connected with a survey I made some years ago. A series of mishaps and blunders from start to finish. The first day plain sailing, until we were on our way home, one of the small boys of creation came pell mell through the bushes alongside of the road, scaring horse; result broken trace. The second day rubber hip boots, at night blistered heel, no moccasins inside of boots. Third day, one of the party slipped off a bog, wet from head to feet. I myself ran into a barbed wire, big tear in one boot, a wet foot balance of day, besides a scratch across the face.

The fourth day was the banner day. What with cutting brush, beating down bogs, getting tangled in cat briers, and the surveyor's enemy, swamp sumac, it was simply great, for many reasons. For the ten days following, did not go to work. I could scarcely walk, arms swollen, face swollen; one of my assistants could not see for three days, the other in bed. And when we did return, found out that the party who was having the work done had made a blunder in his instructions, where we started in the second day's work; giving as a parallel line 200 feet from a stone wall which had to be staked, when it should have been 100 feet from said wall, taking us out of the swamp on good working ground. Started in fresh, and completed the same in about 1½ days. The party paid for three days without a protest. Since then I have very carefully looked at every brush or tree that has to be cut. Do not care for a repeated dose of sumac poison.

C. O. Brown.

Danbury, Conn.

I send the following, which may give a man thought or may not.

In running out and establishing lines of property by following old surveys, we often find expressions like the following:

1st course N 40° W = distance.

2d course East on line of lots, distance—and no fence or indication thereof sufficient to determine what that course was, and in the course of the survey this expression may occur substituting several times W, S or N. This was the custom of the surveyors from early times up to about 1850, and has a definite meaning or significance and refers to the original line of lots in that division, but this is further complicated by a custom of surveyors of that date of setting their compass on a known line and changing the variation vernier to read the same as in some previous survey, in dividing up the original lots for sale of parts thereof or among different members of the family; and this practice leads to other difficulties.

A highway is laid out with the vernier set off and the lines or angles of the highway are only indicated by stake, which in the process of construction has rendered it impossible to locate them except the terminii are sufficiently indicated to form a base for triangulation, assuming as long a line as possible of one of the longest courses and by going over it twice or more dividing the sum of variation among courses in order to determine the error in base line. In following this method, I have been able to relocate road lines satisfactorily to interested parties so far. And in this connection I would suggest that every town should have a copy of the original division of lots and as accurate a map of same as can be made for use in settling disputes.

ROSWELL ATKINS.

Bristol, Conn.

From my experience, I should begin with labeling field books by the year, so that the date may serve to show the time or year in which the survey was made in order to allow for yearly movements of the needle to the west at the rate of 4′ per year since I first came to town in 1857. And again it would be well to note the time of day to allow for the diurnal variation in important surveys.

I deem it advisable to make note of *Back Sights* and *Fore Sights*, as well as angles of deflection, or internal angles for proving and plotting. Said notes being made for the purpose named, viz.: to retrace the lines after the lapse of time since the original survey was made. Local attraction in this region is so prevalent, that one can place but little confidence in the needle, especially in the midst of the city where are water pipes, telegraph and trolley wires and iron posts, and magnetic ore, etc. In fact, my practice is to tie up my angular points to as immovable objects as I can. But fires destroy buildings, and in rebuilding, they are liable to be built differently from the original, so that bounds have to be relocated by a tie to the new building instead of the old one, as originally done. Again streets are changed, either widened or made narrower, rendering it necessary to be on the alert to keep the run of the changes constantly being made. Property owners are either selling a part or buying a part of adjoining properties, without the knowledge of the surveyor, rendering it necessary to consult the records to find out what has been done in the absence of the surveyor. Then again some would-be surveyor, who does not know how to allow for yearly variation of needle, will give lines not allowing any variation, and so land to left of original bound, while again, another in attempting to retrace an old line by allowing the variation will as likely add the variation to a northwest and southeast course when it should be subtracted to give the true modern course, or subtract the variation from northeast and southwest courses where it should be added, and so make a double error.

My simple rule is, turn to the right of the course originally taken by adding the variation to northeast and southwest and subtracting the variation from northwest and southeast courses.

I find occasion to reconstruct plans incorporating changes suggested, dating the time of reconstruction, and by note or plan referring to book in which notes of survey were made.

I find heavy paste-board trammels useful, cut by a movable knife fastened to a slide holder set to the number of inches radius required to the scale of plan on which it is made, by dividing the radius of the curve in feet by the scale of feet to the inch, giving the inches radius to set the cutter from the center.

I have occasion to do field work without an assistant, in which I use a steel upright bar 2′ long $^{3}/_{100}$ foot square, as represented in Fig. 1.

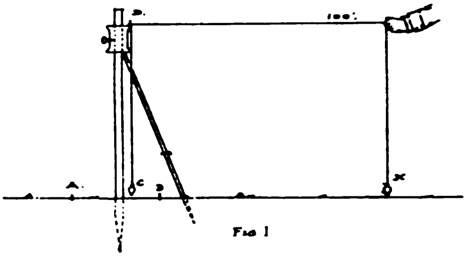


Fig 1

Set plumb C at random in line of *a b d* and add *a c* or subtract *b c* as case may require for giving distance to *x*.

Two flag poles can be used in the same way as shown in Fig. 1, only using a larger movable bob.

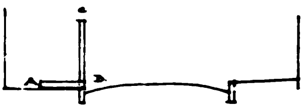


Fig. 2.

As substitute for a rodman, I have used a wooden form, *a b c*, *b c* being a round upright fastened to a flat strip *a b* so as to hold *b c* vertical. By using two they can serve as rangers in running out curves by offsets, or as back sights and fore sights, with or without instrument. Fig. 1 can be used to advantage in connection with Fig. 2 in absence of rodman.

In office, isolated plans are placed in groups and labeled after the names of one or more persons, and in drawers specifying location. In this way any particular plan is readily found by turning over comparatively few in the separate groups.

I do but little field work, as it is with effort that I get around owing to lameness, but I can do office work with comparative comfort. But in order to connect isolated plans, I have to resort to use of figures 1 and 2 to take the place of rodman, or knife to hold tape to corner of buildings in getting size or relative position of one building with another.

I find my latest improved pantograph quite useful in reducing maps drawn on large scales where I want to incorporate an [illegible] *plan* of a combination of several into one, and by transfer paper place on plan. I keep at it fodder or no fodder, as the saying is, and when I get through, my papers will be of such kind as combine my own idea and will explain themselves; while town records that describe deeds as bounded north by *a*, east by *b*, south by *c*, west by *d*, will serve the purpose of the one who makes such deeds better than the one who undertakes to plot it or find the bounds adjoining.

I think I will add but one more suggestion in respect to a question, how to obtain the variation of the needle from the true north. In reply, I would say that I get the true north by the image of the sun shining through a *small hole* in a strip of tin fastened to an upright post on south side of a level board. Through said *hole* suspend a string holding a plumb-bob, thus fixing a *point* on the board plumb under the *hole*, using said point as the center of a circle described with *radius* reaching from said hole to the image of the sun cast upon the board at, say 9 or 10 A. M., describe a circle, and in the afternoon, when the image of the sun intersects the circle as above described, make a mark and divide the space between the first named image and the last, making a third point on the circle, from which draw a line to the center of the circle. Then with a fine twine extend the line to two points north and south of the board and set a stone with drill hole at each and thus establish the true meridian. Set the transit over one of said stones and sight to the other, and note the variation. Then set the instrument over the other stone and sight to the first one and note the variation. If they agree, it is presumptive evidence that there is no local attraction. If they don't agree, turn a right angle over each stone and measure to right or left, say 100 feet more or less, or extend the line to new points, over which set the transit and note the variation till two or more points indicate the same variation, and in that way ascertain the true variation. In this way I found the true variation in this place to be, March 19th, 1901, at

$$\left.\begin{array}{l}\text{9.38 A. M.}\\ \text{to 12 M.}\end{array}\right\} 11.^\circ 50' \qquad \text{and } \left.\begin{array}{l}\text{12.45}'\text{ P. M.}\\ \text{to 2.45}'\text{ ''}\end{array}\right\} 12^\circ.$$

Or average 11.°55'.
In 1866 it was 9.°30' by Col. Lester,
1901 County Surveyor.

35 years. 2.°25'=145'=Diff.

$$35\overline{)\begin{array}{l}145\\140\end{array}}(4' \text{ per year.}$$

As my observations in 1901 were somewhat elaborate, I conclude it best to send you a blue print, with tabular statements of variation of the needle in five different points in my yard indicated by letters A, B, C, D, E. At all of the points it appears that the variation differed on parallel lines, when theoretically they ought to read the same, were it not for local attraction, and at none except at C did the variation conform to the anticipated 4′ per year since 1866 at 9.30 as noted in Col. Lester's table.

Hence I conclude that local attraction and diurnal movement of the needle west of about ¼° from 9.15 A. M. to 1 and 2 P. M. stand in the way of determining the yearly variation other than by comparing the readings of lines between known bound and known date of original survey, and by this method I have arrived at the conclusion that 4′ per year is to all intents and purposes the true variation since 1857, at which time, according to Col. Lester, the variation is as shown in Table 1 (p. 80).

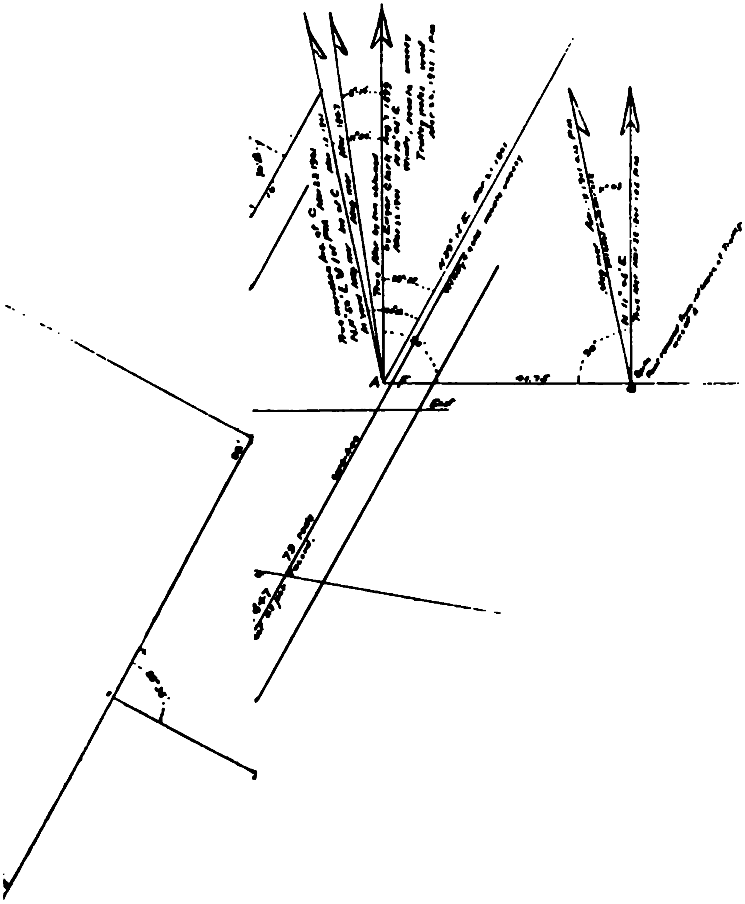
The following shows magnetic courses of true meridian as established by the sun August 7th, 1899, by Edgar Clark in centre of yard north of said Clark's house, Putnam, Conn., at point *A* upon a level plane board, according to Scammel's Universal Treasure House of Universal Knowledge, 3,000 illustrations, pages 1041, 153 Pearl street, Boston, Mass.

Local attraction at *X* due to the city water pipe being the same in 1892 as in 1901, causing a lack of parallelism of magnetic meridian at *C*, but still a yearly variation of 4′ at *X*, or 35′ from 1892 to 1901, a period of 9 years.

This note was taken April 19th, 1901, as N 51° 15′ W, and under same conditions July 4, 1892, as N 51° 50′ W, and according to rule for NW courses = — 35′ var. which if the original was NE would be + = 4′ per year.

The above was taken with Mr. Card and his assistants, and Buff & Burger instrument. Remark, viz., while similar results have followed like comparison of old with modern courses. But where local attraction exists as it does in Putnam, it don't answer to place too much dependence on the needle.

Also shows variation of magnetic needle west of true meridian 1901 of 11° 50′ in Putnam, Conn. Latitude 41° 55′, longitude 71° 55′, showing variation of 4′ per year since 1840 to 1901, discarding local attraction and diurnal variation of ¼°


A
F

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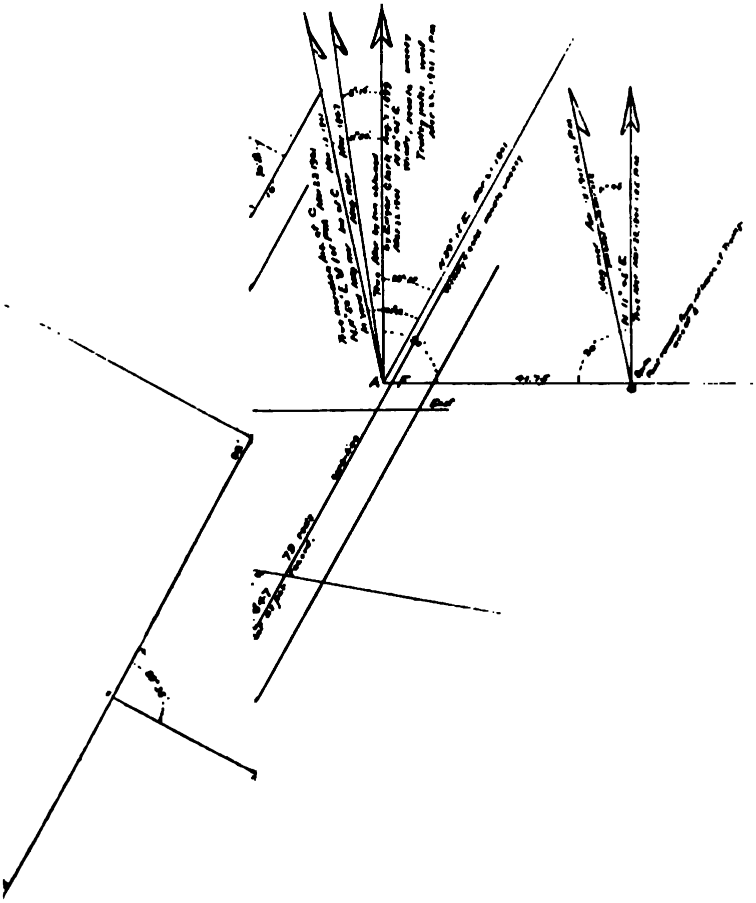

A
91.78

P. M.; there being no record of time of day, of original courses, etc.

Where local attraction exists it follows that magnetic courses in different points of location, reading the same, are not parallel. Therefore it is important in defining the variation of the magnetic needle from the true north, to avoid adopting a magnetic course for comparison with the true meridian—that is affected by local attraction—which may be determined by successive trials of the magnetic course of a number of points in any given straight line. From comparison of old courses with modern courses of lines of undoubted originals, I should suspect results at variance with 4′ per year as in keeping with variations shown in Table No. 1. See also Tables 2, 3, 4, 5 (pp. 80, 81).

April 3, 1902, note, points G. C. X. are removed from influence of telegraph and trolley wires in street.

A represents a point in line parallel with curb 1 ft. distant therefrom and opposite third trolley pole on curve. Top edge of cut, spike and three stones.

To find meridian by the sun see Fig. 1. Fasten a level board to the ground and at the south edge drive a stake *AB* firm in the ground. On its end fasten piece of tin perforated with a hole. Let the string of a plum bob hang through the center of the hole and thus get a point in the vertical marked *V* in the diagram. About 9 A. M. mark the centre of the image of the hole at *D*, then with the line *AD* as radius describe an arc of a circle and when in the afternoon the image of the hole falls on this line as at *E*, mark. Then the line *VF* which bisects the angle *DE* is the true meridian. The image of the sun describes a flatter circle than the one described by the radius *DB* by reason of higher altitude of the sun at noon.

TABLE 1.

Col. William Lester's variations as noted :

1745.	Variations of magnetic, 8.° west of true N.	
1810.	" " 5.°30' " "	
1840.	" " 7.°45' " "	
1866.	" " 9.°30' " "	
1901.	By Edgar Clark, as shown above per plat at points A, B, C, D, F, 11.°45', at G 11.°50, at C parallel lines showing in four tables the magnetic course of true meridian instrument at A, B, C, D, indicating variations due to slight local attraction ; also diurnal variations due to various times of day, readings were taken.	
1901.	Variations of magnetic, 11.°50' A. M. 12.° P. M.	in keeping with 4' per year from 1840 to 1866, and as per table No. 4. Instrument at C.

TABLE 2.

Instrument at A.

Magnetic courses of true meridian from A to B March 18, 1901 :

10.20 A. M.	N. 10.°00' E.
11.00 "	" 10.°00' "
1.00 P. M.	" 10.°15' "
3.00 "	" 10.°20' "
4.00 "	" 10. 15' "
5.10 "	" 10.°00' "
Average	10. 7')

TABLE 3.

Instrument at B.

Magnetic courses of true meridian, B to A August 7, 1899 :

1.15 P. M.	N. 10.°35' E.
[illegible] "	" 10. 00' "

August 8, 1899.

[illegible] A. M.	N. 10.°15' E.
10.00 "	" 10. 00' "
11.15 "	" 10.°30' "
12.00 M.	" 10.°30' "
12.42 P. M.	" 10. 35' "
[illegible]	" 10. 20' "
[illegible]	" 10. 30' "

May 12, 1900.

[illegible] M.	N. 11.°00' E.

Instrument at B.

Magnetic course of true meridian, March 20, 1901:

9.00 A. M.	N. 10.°15′ E.
10.00 "	" 10.°30′ "
11.00 "	" 10.°45′ "
12.00 M.	" 10.°40′ "
1.00 P. M.	" 10.°50′ "
2.00 "	" 11.°00′ "
3.00 "	" 10.°45′ "
4.00 "	" 10.°30′ "

(Average.............10.°36′)

TABLE 4.

Instrument at C.

Magnetic courses of true meridian from C to D, March 18 and 19, 1901:

March 18.		March 19.	
9.15 A. M.	N. 11.°45′ E.	9.38 A. M.	N. 11.°50′ E.
10.20 "	" 11.°45′ "	10.30 "	" 11. 50′ "
11.00 "	" 11.°00′ "	11.30 "	" 11.°50′ "
" "	" 11.°45′ "	12.00 M.	" 11.°50′ "
1.00 P. M.	" 11.°50′ "	12.45 P. M.	" 12.°00′ "
3.00 "	" 12.°00′ "	1.45 "	" 12.°00′ "
4.00 "	" 11.°50′ "	2.45 "	" 12.°00′ "
4.28 "	" 11.°50′ "	3.45 "	" 11.°50′ "
		5.30 "	" 12.°00′ "

Average, 11.°47.′

TABLE 5.

Instrument at D.

Magnetic courses of true meridian, March 20, 1901:

9.00 A. M.	N. 12.°00′ E.
10.00 "	" 12.°10′ "
11.00 "	" 12.°00′ "
12.00 M.	" 12.°10′ "
1.00 P. M.	" 12.°00′ "
2.00 "	" 12.°15′ "
3.00 "	" 12.°00′ "
4.00 "	" 12.°00′ "

(Average	12.°4′)	D.
"	11. 47′	C.
"	10. 7′	A.
"	10. 36′	B.

General average.............11. 9′

EDGAR CLARK.

Putnam, Conn.

The Conditions under which Men are Employed at Keney Park.

First—No man is hired for any definite length of time. Every employee's time is out every night, and any or all of them are at liberty to quit at any time they choose, for any reason or for no reason, without breaking any agreement or understanding with me. I also have the same privilege in letting them go. The only bond which holds us together is our mutual advantage and pleasure. In point of fact, men work here year after year and there is very little change, except as men go out for better positions or pay.

Second—No drunkenness; no swearing; no smoking during working hours. Any signs of intoxication on or off the work, known by me, discharges the man at once, and also if I hear him swear. No exception is made to these rules, be the position high or low. Although these rules were not made for that purpose, yet they have resulted in bringing to the park the best workmen, and in fact men able and willing to accomplish more in a day, and they also almost entirely eliminate the causes of accident.

About one hundred men are employed, and there has been no difficulty in obtaining or keeping men under these conditions. The rules act as a screen. The poor men drop through. Character has a commercial value in laborers as well as in bank cashiers.

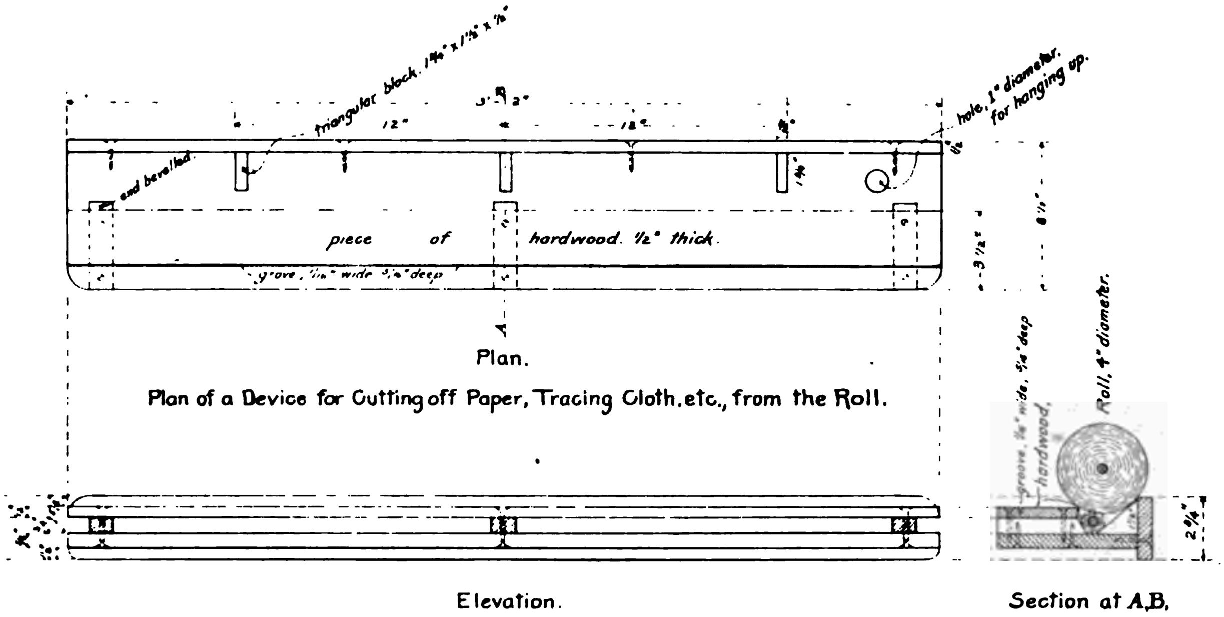
G. A. Parker.

Hartford, Conn.

A Device for Cutting off Paper or Tracing Cloth from Rolls.

A convenient device for use in cutting off pieces of paper, tracing cloth or blue print paper from the rolls is shown in the accompanying sketches from the plans for one in use in the office of the writer. One or two features only of this design are original, it being an improvement on a somewhat similar contrivance in use elsewhere.

In using this device, it may be placed on the end or side of a draughting form or drawing board. The roll of paper should be placed as shown in the cross-section sketch, and the end of



Plan of a Device for Cutting off Paper, Tracing Cloth, etc., from the Roll.

the paper pulled out from underneath the roll until the length needed has passed the groove. Sufficient tension should be applied to make the paper thus drawn out straight and smooth, and one or two weights should be placed on the paper to keep it tight while the piece is being cut off. The blade of the knife used should be thin, and its edge should be sharp. It should be drawn across the paper following in the groove. A good table knife, which by long use has become worn rather thin, is suitable for this purpose.

The weight of a full roll will furnish sufficient resistance to the proper tension for the paper to be cut off. As the roll decreases in size and weight it lies lower down relatively to the edge of the hardwood piece over which the paper is drawn, which compensates for the decrease in weight. When the roll is nearly gone, a weight may be placed upon it to counteract the pull. When not in use, the thing may be hung up beside the T-squares and triangles.

If a hole is bored for that purpose, it should be about in line with the center of gravity, and not as shown in the sketch. A screw-eye may be used instead of a hole by screwing it into the end of the lower horizontal piece. If the roll is longer than the device itself, part of the width may be cut off, and the roll may be moved along sufficiently to finish the cutting.

The following are some of the advantages of its use:

It holds the roll [illegible] while the piece is being cut off and prevents the roll [illegible] the board upon the floor and being thus soiled [illegible]. It avoids waste, as the paper [illegible] at right angles. It takes less time, and is more convenient than the usual method.

The cost of the one in use in this office was $1.75.

E. P. AUGUR.

[illegible]

REPORT OF COMMITTEE ON STEAM RAILROADS.

To the President and Members of the Connecticut Society of Civil Engineers:

GENTLEMEN:—The following communications, which cover the field quite thoroughly, comprise the report of your committee for this year:

In response to your circular relative to construction in the State of Connecticut during the past year, beg to give you below general information concerning important pieces of work completed during the year or now in progress by this company in the State.

BRIDGEPORT:

The entire work for the substructure in the four track improvement through Bridgeport is now under way. Contract has also been let for four track Scherzer Rolling Lift bridge across Pequonnock River. It is expected shortly to award the balance of the steel work, including the bridges over the different streets and the steel trestle work along the water front. It is also expected that the new station will also be contracted for in the near future, so as to be completed with the balance of the work.

WINDSOR:

The change of Broad street crossing from grade to under the tracks of our Hartford Division has been completed.

NAUGATUCK DIVISION:

Contract for the grading, masonry, etc., for the double tracking of the Naugatuck Division from the present end of double track south of Derby to Ansonia, has been let and the work is now well under way. This improvement provides for a change of line through Derby, the new line being located on the meadows about midway between the present Ansonia Branch and the Naugatuck Division.

PLAINVILLE:

A new union brick passenger station has been constructed at Plainville for our Northampton and Highland Divisions, taking the place of the old station on the Northampton Division destroyed by fire and the former Highland Division station.

THOMPSON:

The grade crossing at the station has been changed from grade to over the tracks of our Midland Division.

NORTH GROSVENORDALE:

The grade crossing located about half a mile south of the station has been changed from grade to over the track of our Norwich Branch.

This covers the more important pieces of work undertaken by the company during the year in the State.

COLIN M. INGERSOLL, JR.,
Chief Engineer.

To the President of the Connecticut Society of Civil Engineers:

Responding to your recent favor, and as a member of your Committee on Steam Railroads, I submit herewith a report of such work as has come under my observation during the past year. While much of the work done has been routine, there are a number of important improvements to which I shall make a brief reference.

What is doubtless the most complicated and expensive piece of work ever undertaken by a railroad in the State of Connecticut, is now under construction at Bridgeport, and is known as the "Bridgeport Improvement." This work involves the elevation of the tracks throughout the entire length of the city, thus eliminating all grade crossings; the partial change of alignment; the construction of a new rolling lift drawbridge; the erection of a new union passenger station, with the necessary approaches thereto, and the building of a new freight storage yard with many miles of track, at the east end.

The work, temporarily discontinued, was resumed early in the summer, and has been pushed forward with all possible expediency. Owing to favorable weather, there has been no cessation of operations during the winter months, and there are at present between 400 and 500 men employed.

The huge job is divided into three sections, each of which is let as a separate contract, there being three different firms engaged in doing the work.

The entire improvement is under the personal supervision of Mr. R. M. Berrian, Member American Society C. E., aided by a corps of able assistants.

The double tracking of the Naugatuck Division, from the end of the present double track section, northward, is also under way, and very satisfactory progress is being made.

This improvement entails several changes in alignment, a reduction of grades and the elimination of all grade crossings.

The section under construction is about four miles long, and extends to, and includes, the Ansonia yard.

This work is also under the supervision of Mr. Berrian.

At Cos Cob, on the New York Division, another of the huge masonry piers has been erected, under the high bridge which crosses the Mianus River at that point.

These piers are built wide enough for four tracks, and when all are completed, it is presumed that a new four track bridge will replace the double track bridge now in service.

At Plainville, on the Air Line-Northampton Division, a new and elegant union passenger station has been erected during the past summer. The outside is of speckled buff brick, with sawed blue stone trimmings, while the inside walls are of cream-colored buff brick.

The wainscoting, ceilings, toilet rooms, ticket office, etc., are finished in hard wood, the whole combining to make a very pleasing effect.

The building is heated by steam, lighted by electricity, and the plumbing is of the most modern description. Commodious platforms with ample cover sheds make the station easy of access in all weather, and the patrons of the road are highly pleased with the much improved arrangements.

At Still River, near Brookfield Junction, a new steel plate girder bridge has been put under the tracks of the Berkshire and Highland Divisions; the tracks of these divisions running parallel at this point.

The separation of grades at the "Causeway" crossing, at Windsor, on the Hartford Division, is a vast improvement over old conditions, and is much appreciated by those having occasion to use that thoroughfare.

This article would be incomplete without a brief reference to the immense ice plant recently installed at Poquonnock, on the Shore Line Division. The building is probably the largest ever erected for the purpose in New England, and is capable of receiving and storing many thousands of tons of ice.

All of the machinery used in loading the ice into cars is of the latest and most approved design, and the numerous side tracks, with frequent switches and crossovers, tend to facilitate the handling of cars with the least possible delay.

While I have mentioned some of the improvements made by the N. Y., N. H. & H. R. R. during the past year, it will be noticed that I have confined my observations to improvements *in Connecticut*. Much important work has been done on the several divisions *in other states*, to which I have made no reference.

George E. Palmer.

(Signed) Morrison C. Hamilton,
Charles H. Ewing,
George E. Palmer.
Committee.

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	Rail section [illegible]	Remarks
[illegible] Quarry RR. Maromas, Middletown, Conn.	2 [illegible] new [illegible] [illegible] track	[illegible]	Not by contract. Not known by me.	Old track being relaid with [illegible]5 lb. rails.	1¼ miles of additional to Whitmore's quarr laid out, not built. Changing alignment present road to impr curves from minim R. of 10° curves, minimum of 10° and curves.
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] lb. Am. Soc. C. E.	Not in state, but in cha of Eng. resident of sta

REPORT OF COMMITTEE ON MASONRY.

The Connecticut Society of Civil Engineers:

GENTLEMEN:—The undersigned, being the Committee on Masonry of the Connecticut Society of Civil Engineers, report as follows:

We have received statements from Messrs. Harold Parsons, W. S. Clark, C. B. Vorce, Wm. E. Smith, R. Miner, C. O. Brown, C. H. Ewing and W. E. Truesdale, and also one other report to which unfortunately the signature was not attached. All the above came through Mr. Kellogg in answer to circular letters sent out by him.

We have also received letters from Messrs. C. B. Vorce, C. N. Wood, A. B. Alderson, C. H. Ewing and Ely M. T. Ryder, in which said gentlemen have taken the trouble to write more fully regarding certain work which has been done under their respective supervision. Mr. Alderson and Mr. Ewing have sent us photographs with their reports, which we attach.

We have recently run across a specification for concrete foundation work to be done in Virginia; in which the engineer has specified exactly, the number of cubic feet of both sand and stone required per barrel, instead of giving the ratios only, as is usual. This is evidently done in order to avoid all possible diversity of opinion regarding the dimensions of the basing unit, and we would gladly have the expression of the members as to their opinion regarding this course.

Respectfully submitted,

CHARLES M. CRAWFORD,
ELY M. T. RYDER,
CHARLES N. WOOD,
Committee on Masonry.

You asked me to-day to give you an account of the concrete masonry we are building on the Greenwich and Johnsonville Railway. All our concrete is gravel concrete. We run through a country where gravel is plenty, and on a number of the structures the gravel is immediately at hand. The cement we use is "Ironclad Portland," made at Glens Falls,

N. Y., about eighteen miles above us. The general mixture is 1 part cement, 2 parts sand, 2½ parts of gravel less than ¾" diameter and 5 parts gravel ¾" to 2" diameter. My theory is that the voids in the larger gravel can just as well be filled up with small gravel as long as there is enough mortar to *stick* the gravel together. This has been proved by experiments I have had made, and we are getting a monolithic mass which will break the quartz gravel before it will break the bond in the cement. Part of the concrete has been mixed by hand and part by a Ransome mixer. This little mixer gives almost perfect results and the mixture is turned about thirty times before being used. The bridge seat mixture is composed of 1 part cement, 2 parts sand and 4 parts ¾" gravel. The facing mixture is 1 part cement and 2 parts sand. Part of the facing has been put in by plastering the form just ahead of the concrete and part by putting a form 2' back of the forms with 2" piece on it. After the facing mixture has been put in, the concrete is put behind the board. We then pull up and the concrete is tamped to form a bond between the concrete and facing mixture. Both of these ways have given fairly good results. The structures have to be worked with a cement grout to fill up the small holes and to give the whole a smooth appearance. To obtain a perfectly smooth finish, however, I think the facing should be floated on after the structure is completed. This latter way is the plan used by the New York Central Railroad.

In some of the culverts I have used expanded metal lathing with the concrete, [illegible] have had good results.

[illegible] been very particular to keep the gravel worked clean and free from [illegible] matter and with good sharp sand and good [illegible] have had good results. Any other question you [illegible] be very glad to answer.

C. B. VORCE.

[illegible]

[illegible] the usual amount of masonry [illegible]

[illegible] it has been our custom, in Norwalk, to [illegible] wooden bridges that have become worn or rotted [illegible] stone arches. Said arches have all been of rough [illegible] work from native stone laid in Portland cement mortar:

mixture 1 cement to 3 of sand. Most of the stone, excepting the arch stone and coping, have been taken from boulders, of which we have a great quantity; many of a good quality of granite. The arch stone and coping have been from quarry stock, plug and feathered, which at the work have been trued up, along the edges and ends, so that they will lay fairly close when in position. The coping is roughly squared at the ends of each stone, and the edges roughly lined with an edging tool. All plans have been made as plain as possible on account of the roughness of the stone. Care has been taken in dressing boulders to avoid round surfaces on the beds or builds. So far, twelve of these arches have been constructed from a span of four feet up to fifty feet. There is now in course of construction one bridge of two end spans of thirty feet each and two center spans of thirty-five feet each. Work was stopped in November on account of the cold weather and high water in the Norwalk River.

The cost of the arch bridges as herein mentioned has been about as follows:

Coping and arch stone	$8.00 per cubic yard.
Foundations	5.00 " " "
Piers and abutments	4.00 " " "
Sidewalls	4.00 " " "
Loading (dry)	1.50 " " "

The above prices I believe to be too low, as I am sure very little money has been made by the contractor doing the work.—C. N. W.

During the past year I have had occasion to repair a masonry dam for the Water Commissioners of the City of Norwalk. The dam was built in 1870 and '71, and has always leaked more or less from the first, the length of the dam being about 250 feet on top, and the height above the present surface 25 feet. For a length of 130 feet in the center, the masonry extended down 12 feet below the present surface, making the height in this section 37 feet. Although it was supposed to be solid cement rubble masonry, I found very much of it, especially the backing, laid dry or nearly so, while the cement mortar used was of such poor quality that, excepting the face pointing, it was little better than mud.

The back of the masonry was filled with earth in the usual way, no attempt having been made to remove the stone and small stumps from the same. This earth filling was hoisted out along the entire length of the dam, so that a space four to five feet in width was obtained at the extreme bottom. All joints were carefully cleaned with proper tools and then washed out, after which cement mortar was forced in and the joints carefully pointed up. I found the wall to be two feet narrower upon the inside, at the extreme bottom, than it was twelve feet up, or at the present surface at the bottom of the reservoir, showing that the contractor who built the dam excavated for the foundation and laid the stone to the full limit of the excavation, thereby forming an overhang upon the inside of the work. As the dam had at some time yielded under the pressure behind it, which is clearly shown in the line of the coping, and as the masonry at the bottom seemed to be none too thick, a concrete wall of Portland cement and stone was formed 2½ to 3½ ft. thick upon the bottom and carried up plumb until the point of overhang was passed, and then on the batter of the masonry about one foot thick up to a point or line which is about five feet below the level of the spillway, at the east end of the dam. The joints in the face of the dam were pointed up after having been dug and washed out, and after the mortar had thoroughly set, holes were drilled at the points where three stones came together. These holes were from 2½ to 4 ft. in depth, and of such diameter that 1½" iron pipe was easily inserted, then by using an elbow, the pipe was carried up to a point about six feet above the top of the dam. A funnel was attached to the upper end of the pipe and Portland grout was poured into the funnel by a man standing upon a barrel. This operation was continued in each case until the grout ceased to [illegible]. As the extreme cold weather in November hindered this operation the work was stopped for the season, to be resumed in the spring. After stopping work, the reservoir was allowed to fill, and water has been running over the spillway ever since. Although the work of repairing has not [illegible] feet of the height of the top of [illegible] estimate that fully 85 per cent. [illegible] has been stopped. This dam rests upon a loose, [illegible] ledge at each end, and upon gravelly hardpan for a distance of [illegible] feet in length in the center. The spillway being at the extreme east end is directly over the ledge, and consequently the overflow falls upon the same. Six hundred barrels of Alpha Portland cement were used in these repairs, besides a few barrels of Atlas and other brands which were used at times when the Alpha failed to arrive on time.

About three hundred yards of dry retaining wall along the roadway close to the reservoir was taken down and rebuilt during the time the dam was being repaired, some of it having been undermined and other portions crowded over and overhanging. All the stone used in construction of the work seemed to be of good quality, the face stone having cut beds and joints with rock face, the backing being of large stone and fairly good as to shape. The repairs to dam as mentioned were by day's work.

C. N. WOOD.

Norwalk, Conn.

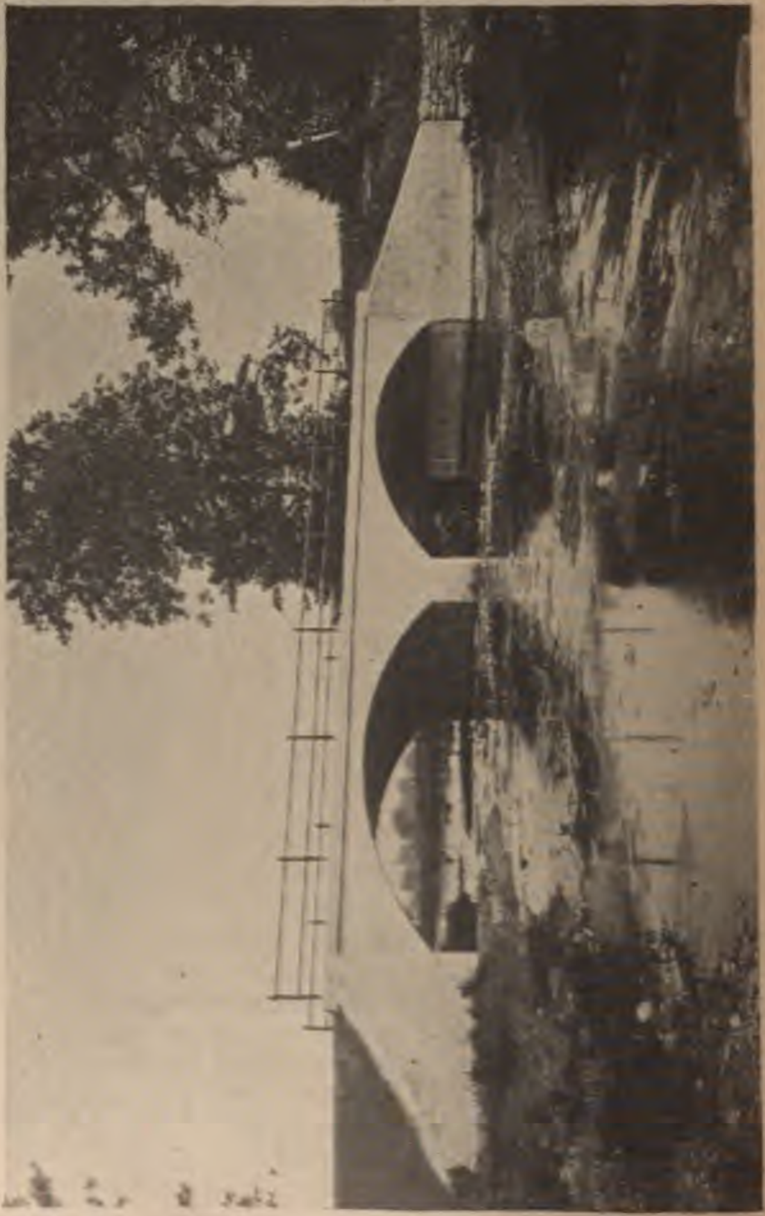
Answering your favor in reference to masonry construction in the town of West Hartford, I may state that during the past year we have replaced two old wooden bridges with structures built entirely of concrete. The first one, known as the Elmwood Arch, consists of two spans, each twenty-six feet in the clear, with a rise of five feet, and depth of crown twenty inches. The roadway is twenty-four feet in width; and upon the parapets a railing was placed, consisting of two-inch gas pipe. The proportions in mixing concrete for the foundations and spandrel walls were 1, 3 and 6, and for the arch proper, 1, 2 and 4. The total cost of bridge was $3,150.

No. 2 is situated on Main Street near Scarretts Mill, and consists of three spans of fifteen feet, with a rise of two feet, and depth of crown twenty-two inches. The roadway is thirty feet wide, and upon the parapets a railing was placed, consisting of two-inch gas pipe. The proportions in mixing concrete for the foundations and spandrel walls was 1, 3 and 6, and for the arch proper, 1, 2 and 4. The total cost of the bridge was $2,950. Both these bridges were built by contract with The Hartford Paving & Construction Company.

Enclosed you will find a cut of the Elmwood arch.

A. B. ALDERSON, *Town Engineer.*

West Hartford, Conn.



ELMWOOD ARCH.

In compliance with yours of January 15th, requesting information on the subject of masonry construction on this road for the year 1901 for use in connection with your report to the Connecticut Society of Civil Engineers, I beg leave to advise you of the following:

At Hartford, Conn., a new bridge on line of Sigourney street has been constructed carrying the street over the railroad. The masonry is random range brown stone, dressed to a uniform thickness and resting on concrete foundations five feet in thickness. Nazareth Portland cement was used throughout; concrete being mixed in the proportions of 1, 3 and 6. Total number of cubic yards was 718. The cost, including excavation for foundation, shoring, etc., for each cubic yard of masonry laid, was $7.47. Adjoining this work a concrete retaining wall 758 feet long was constructed having a cross-sectional area of about 27 square feet. Alpha cement was used, and the concrete was mixed in the proportions of 1, 3 and 6. The broken stone used was of sizes one to two inches. The wall was laid in alternate blocks fifteen feet long, the intervening blocks being built after the form was removed from the adjoining blocks. The bank back of the wall was of clay thoroughly saturated with water, requiring a weep hole of 4" tile pipe in each block. The cost, including all excavation, was $6.75 per cubic yard.

At another point on the road a pier, on which rested a 105-foot through girder, was partly undermined by a spring freshet; the pier was shored up temporarily until the water was low enough to make a thorough examination. Afterwards the pier was supported by timbers, new foundations were dug and filled with concrete in sections, ramming it thoroughly under the old pier, which still held intact. The work was done at a comparatively small cost, and illustrates the great economy of the use of concrete in special cases.

At Poughkeepsie 729 cubic yards of concrete was used in the reinforcement of pier No. 1 of the Poughkeepsie bridge. This pier, located at the foot of the West Rock bluff, was originally built in three sections. On account of the contraction and expansion of the struts connecting the base of the 100-foot towers, it was deemed advisable to fill in the spaces between each section of the pier, and raise the top of the pier so as to enclose

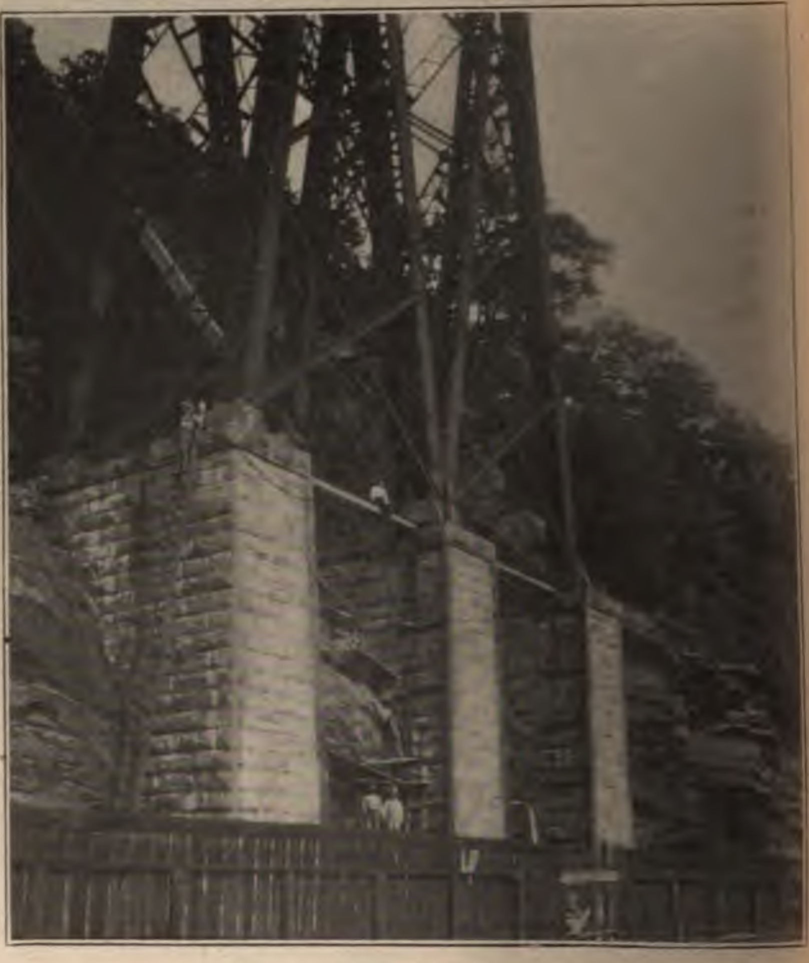


FIG. 1.—POUGHKEEPSIE BRIDGE.

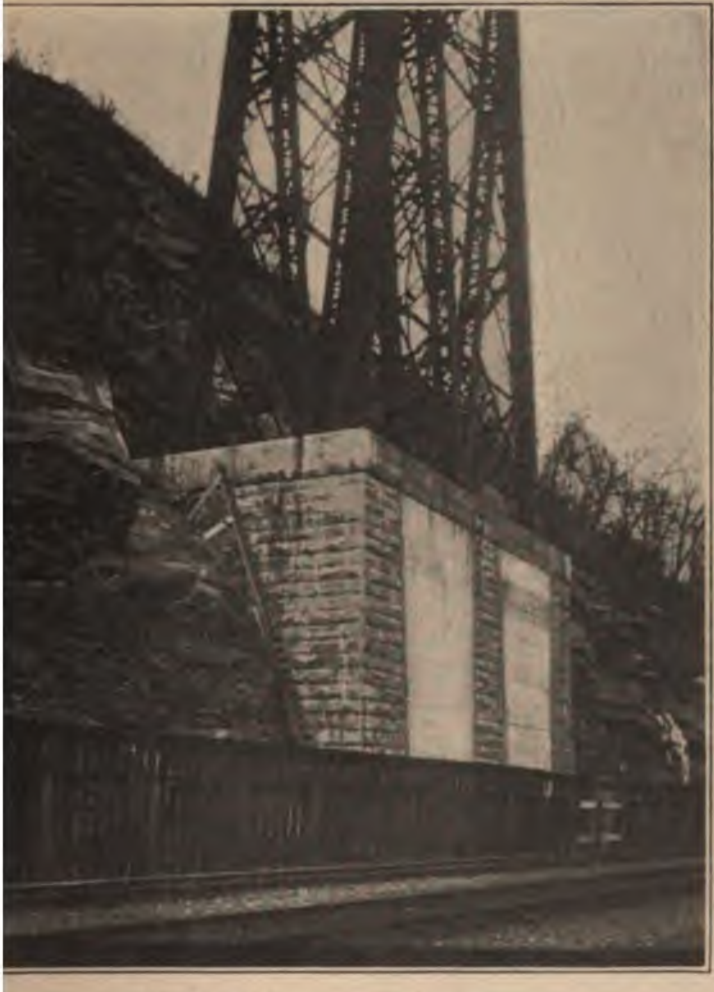


FIG. 2.—POUGHKEEPSIE BRIDGE.

the struts. Concrete was adopted, mixed in the proportions of 1, 2 and 5, using Alpha Portland cement and broken stone, sizes one to two inches, special methods being used to anchor the concrete to the rock bluff. The cost, including excavation of rock bluff where necessary, and drilling for and placing of all iron work, was $6.75 for each cubic yard of concrete laid.

C. H. EWING, *Chief Engineer.*

Hartford, Conn.

In the town of Fairfield, Conn., the Uncowa Water Co. has been building during the past year a concrete dam to impound water in a storage reservoir on Mill River. This water is to be pumped into a distributing reservoir on the summit of a neighboring hill. The masonry in this latter reservoir is also entirely of concrete.

Of the dam across Mill River the central portion, 186 feet in length, is utilized as a spillway, and is continued as a core wall into the hill on each side of the river. This portion has a vertical upstream face and an ogee curved down stream face. The height of the dam above the bed of the brook is about 27 feet, its top width [illegible] feet and bottom width 30 feet, and this last width is continued down to the rock, which is not far below the natural ground level. The concrete is composed of one part of Portland cement, two of sand and four of crushed gravel. It was mixed in a [illegible] type of machine mixer, deposited in 8 inch layers, and wherever placed on old concrete which had already set, the old surface was first covered with a layer of cement mortar—1 cement to 2 sand—about 1½ inch thick. On each face of the dam a 2 inch surface coat of 1 to 2 mortar was constructed as the work progressed.

The concrete used in the walls and floor of the distributing reservoir is of the same proportions as that used in the dam. The point of chief interest here is the use of expansion joints in the walls and floor to allow for variations in temperature. The [illegible] floor is divided into blocks 16 feet square. [illegible] inches [illegible] inches wide around each of the blocks is filled with a mixture of pitch and coal tar, in equal proportions. The walls are built in 30 foot sections with plain vertical joints, but in the middle of the wall at each joint is a vertical rectangular hole or shaft 4 inches in width and projecting [illegible] inches into each of the adjoining concrete sections. This

Kind	Cost, or contract price per cubic yard	Use	Remarks on Location, Excavation, Cement, Mortar, Etc
Rock-face, random-ranged rubble	$4.00 ±	Abutments	Danbury, Conn.—1,200 ± cubic yards. Nazareth and Atlas Portland Cement.
Concrete	Including excavation $6.75	Retaining wall	Hartford, Conn.—738 cu. yds. Alpha Portland 1-3-6.
"		Core at dam, repairs to sewers	Meriden, Conn.—Core at dam lengthened out, with other repairs, plastering, etc., cost about $5,000. All work done by the city.
Heavy, ranged granite, rock-faced Ashlar, backed with granite rubble		Raising dam	Moodus, Conn.—140′ Pourover, laid in Portland Cement mortar 2-1. 85 cu. yds. Ashlar, courses 20 high; 150 cu. yds. Granite mortar-laid rubble; day labor wholly. Total cost, embankment included, $4,500. 16,000 cu. yds. of earth-filling, at 23c per cu. yd., required to raise four roads crossing the flowage. Bridges rebuilt, dry stone work, $2.48 per cu. yd.
	5.00	Sea wall	Sound Beach, Conn.—Mortar 3-1 by measure, Alpha-Portland Cement. Average excavation 3′. Only sea wall out of ten that withstood storm of Nov. 24, 1901.
Concrete	5.08	Retaining wall	Waterbury, Conn.—750′ long, average 25′ high. Portland Cement 1-3-7, crusher run of stone.
Brownstone	5.50	Retaining wall	At river, Portland Cement mortar.
Outside of State.			
Concrete	6.00	Abutments, piers and culverts.	Ironclad Portland Cement, gravel, about 6,000 cu. yds. 7 abut., 17 piers, 4 culverts: 1 155′ long, 4½′x6′ opening. 1 133′ " 4′ x4½′ " 1 153′ " 4½′x6′ " 1 180′ long, 6′ arch, wall 4½′ high.
Rubble	4.25	Foundation walls	Hoffman Rosendale Cement, 2-1, 3,000 cu. yds. } Excavation 15,500 cu. yds., 35c per yd.
"	5.50	" "	Alpha Portland Cement, 2-1 500 cu. yds.
Concrete	5.00	Footings	Hoffman Rosendale Cement 1-3-5, 100 cu. yds.
"	6.50	"	Alpha Portland Cement 1-3-5, 130 cu. yds.
Brick	12.50	Mill construction	Full Hoffman Rosendale Cement 2-1, 600 M. Rockland Lime and Hoffman Rosendale Cement 1-2-3, 520 M.
Concrete	6.75	Abutment	Poughkeepsie, N. Y.—Alpha Portland Cement, 1-2-5, 729 cu. yds.

shaft is filled with the above mentioned mixture of pitch and coal-tar, and occupies an analogous position to the spline in mated timber.

ELY M. T. RYDER.

New Haven, Conn.

REPORT OF COMMITTEE ON STREET PAVEMENTS.

To the President and Members of the Connecticut Society of Civil Engineers.

GENTLEMEN:—Your Committee on Street Pavements begs leave to submit the following report for the year:

No attempt has been made to include statistics of construction at this time, as these will be tabulated and printed in the Proceedings for reference.

It affords us much pleasure to report that all of the inquiries sent out by the chairman were promptly answered, and in each case the information asked for was given in full. We hope our contemporaries in office may have had similar good fortune.

From an engineering standpoint the subject of street pavements seems to offer but little of interest to those not engaged in municipal work, but we hope that mention of the word assessments may serve to hold the attention of our landed plutocrats.

When the convention now at the capitol shall have finished its labors, our municipal charters may, perhaps, be on the road to uniformity and perfection, but at present our methods of assessment for public improvements are numerous and diverse. The street railways, however, are assessed for pavements under a general statute, so their proportion is uniformly nine feet in width for each track.

Of the nine cities and boroughs in Connecticut that have put down improved pavements, only four have assessed any benefits upon the abutting property. Of these, Hartford and Waterbury assess two-thirds and Bridgeport one-half the total cost, while New Haven has the arbitrary rates per front foot of seventy-five cents for granite block, sixty for asphalt, fifty for brick, and twenty for macadam, with brick or cobble gutters.

South Norwalk, Stamford and Greenwich have charter authority to assess a portion of the cost of pavement upon the abutting property, but up to the present time this power has not been used. Meriden and New Britain lack even this, and the cost is paid entirely by the municipality.

Despite the subtle and mysterious influence which asphalt is known to have over the minds of legislators in general, our cities and boroughs have, with one exception, clung fast to the old New England doctrine of "pay as you go." At the last session of the General Assembly bills were introduced authorizing bond issues for pavements, by New Haven, Waterbury and Norwich, —in the aggregate over one million dollars—but they were without support at the committee hearings and were promptly rejected. It was at least noticeable that all three specified "Trinidad Pitch Lake asphalt and nothing else."

Thus far only the city of Hartford has seen fit to issue bonds to pay for improved pavements, so we give a brief summary of the results there, for the benefit of those who may be in a position to mould public opinion.

Under a charter amendment—now repealed—which required the paving of at least one-half mile of street annually, Hartford has laid about two hundred and ten thousand square yards of block and sheet asphalt, besides some granite block, and issued bonds for payment. The guarantee on the latest contract will expire in 1905, and from that time for a period of thirty years —if the bonds are retired at maturity—the city must pay for interest, sinking fund, and maintenance, over twenty-two thousand dollars annually: a sum equivalent to one-third of a mill on the present grand list. This you may compare with the New Haven limit of one-fourth of a mill.

Respectfully submitted,

CHRISTOPHER M. GALLUP, *Chairman.*

Square yards.	Kind of pavement.	Thickness of pavement.	Depth and kind of foundation.	Was Portland or Rosendale cement used?	Average amount of grading necessary.	Length of guarantee.	Contract price per square yard.	Remarks.
123,595	Crushed stone.	6″	——	——	——	——	$ .674	New Haven.
50,432	Vitrified brick.	——	6″ concrete.	Portland.	——	5 yrs.	2.419	New Haven.
2,648	Sheet asphalt.	2½″	6″ concrete.	Portland.	——	10 yrs.	2.81	New Haven, brick gutters.
3,000	Sheet asphalt.	2½″	6″ concrete.	Portland.	10″	10 yrs.	2.98	Middletown.
2,750	Macadam	6″	——	——	8″	——	.57	Middletown.
142	Red brick.	3″	6″ concrete.	Rosendale	4″	——	Days work.	Stamford.

Returns from Springfield, Mass., omitted. Not in State.

REPORT OF COMMITTEE ON WATER SUPPLY.

To the President and Members of the Connecticut Society of Civil Engineers.

GENTLEMEN:—Your Committee on Water Supply begs leave to submit the following report:

In answer to circular letters of inquiry sent to the members of the Society the following work has been reported:

There has been extended in New London during the past season 14,216 feet of mains of various sizes, and 8,703 feet of cement lined mains have been replaced with cast iron, all at a cost of $20,814.29.

In regard to what you call the "scarcity *scare*," the scare was very real to us, reducing our supply until, on March 9th, we had less than sixty days' supply on hand. This condition served to emphasize a fact already known to the department, but hardly realized by the people, that the average amount of water collected was less than the consumption. With a view of remedying this condition, we are now building an additional reservoir of 170,000,000 gallons capacity, connected with our present reservoir by three miles of mains.

W. H. RICHARDS, *Supt.*

New London, Conn.

First: In 1899, 409 feet of 4" iron main laid, 5,851 feet of 4, 6 and 8" cement pipe replaced by iron pipe, costing $3,260.54.

In 1900, 450 feet of 4" iron main, cost $202.

In 1901, 2,059 feet of 4" iron main, cost $983,21. 1,260 feet of 4" iron main to replace cement pipe, cost $616.40.

Rainfall—1899, 33 $^{51}/_{100}$"; 1900, 38 $^{14}/_{100}$"; 1901, 47 $^{87}/_{100}$.

Conditions of Supply.

On June 12, 1899, we had 434 million gallons on hand. On Nov. 29, 1899, we had practically nothing in our four reservoirs, including the gravity and pumping stations. On the last named date we were forced to start auxiliary pumps from an independent source, from which we kept pumping until Feb. 13, 1900, when pumps were shut down. On June 19, 1900, we had on hand 474 million gallons, at which time our Knowles pump at the station was started. In Nov., 1900, our supply was very low, just before the rains of the 25th and 26th, having only 33 million gallons on hand. The rains on the above named dates, however, increased our supply to 157 million gallons, thus placing us out of immediate danger. We have had an abundance of water since that time, and on Jan. 1, 1902, our reservoirs were practically all filled, having on hand about 640 million gallons.

Improvement of System since 1899.

Our experience during the years 1898, 1899, 1900, which I believe was general throughout the State, opened our eyes to the fact that something must be done to prevent, if possible, a recurrence or repetition of those conditions. After deliberation, the City, through its Board of Public Works, decided to first improve our condition at the West Mountain Gravity Supply, using all possible avenues of supply to increase the volume for storage and distribution. The first step taken, which covered portions of the years 1900 and 1901, was to improve our condition at the South Dam at Merimere Reservoir. This reservoir is our main gravity distributing reservoir—capacity 357 million gallons. At this dam, prior to the improvement, there was a leakage of about 500 thousand gallons daily when reservoir was full. We could use only a small portion of this leak, the remaining portion being a dead loss. The improvement made consisted in excavating back of the concrete core, extending and lengthening same, facing with two coats of Portland cement and afterwards backfilling excavation with clay puddle. The expense incurred was approximately $5,000. Examinations made since its completion show that we have throttled the leak from 77 to 85 per cent. (A very satisfactory result.) We can now very easily use the small portion of water finding its way through the dam, it being collected in a small pond just under the main dam, from which it is turned into our distribution pipes. The next step which we hope to take is to improve the condition of our canals, so that we may be able to derive the full benefit of the shed area tributary thereto. This work I hope we shall be able to do the coming summer. When this is done we will, I believe, have practically stopped the waste by leakage. The waste by consumption cannot be stopped except by a system of meters, the introduction of which, I believe, is only a question of time.

W. S. Clark, *City Engineer.*

Meriden, Conn.

Replying to your circular letter of inquiry for water work statistics, to present in your report at the annual meeting of the Connecticut Society of Civil Engineers, would say, that we have designed during the past year, and have now in process of construction, a water plant for the village of Groton, which it is hoped will be in operation by the 1st of next June. As there is no available gravity supply, the plant is of necessity a pumping plant, and our plans contemplate the installation of two power pumps, each of 720,000 gallons or 500,000 gallons capacity per minute respectively; two horizontal turbine wheels of about 45 horse power each, connected by a friction clutch so that they can be operated independently or as a unit, and a multi-cylinder gasoline engine of about 80 horse power for auxiliary power.

We hope to be able to operate the pumps by water power for about ten months in the year, and, as there will be considerable surplus power during the winter months, the arrangement of plant will be such that this surplus can be utilized in connection with a small electric lighting station to be located under the same roof.

A steel standpipe, 30 feet in diameter and 65 feet high, and about nine miles of pipe, sizes 10, 8 and 6 inch, complete the principal items of the plant.

Total cost will not be far from $100,000 for the water plant alone, the electric lighting plant being a separate and independent investment, though owned and to be operated by the same stockholders, organized in two companies known as The Groton Water Company and The Groton Electric Lighting Company.

If the completed plant is thought to have any features of sufficient interest to warrant, we will, perhaps, give a detailed description at some later date.

Daboll & Crandall.

New London, Conn.

The city of New Britain during the past year has laid one and one-half miles of 6" and 8" pipe, has cleared 11 acres of land for a reservoir on Wolcott Mountain, and has changed the inlet of one of our canals at Shuttle Meadow Lake to avoid deposit near gate house. The change required building about 1,500 feet of canal, but the results justified the expense.

W. H. CADWELL.

New Britain, Conn.

Amount, size and cost of main pipes laid:

26780 feet,	20 in. pipe.
48892 "	12 "
5916 "	10 "
13714 "	8 "
46738 "	6 "
16262 "	4 "
2049 "	3 "
2456 "	2 "

Cost, $334,514.71.

Cost includes 12 miles of cement pipe relaid with C. I. pipe.

There have been laid during the year 854 feet of 6 in. cast iron pipe, at a cost of $616.24.

The scarcity scare of 1899 has brought about the necessity of providing a storage supply largely in excess of consumption, and the free use of meters to stop the waste.

We have done some planting during the year, as a beginning in applying the rules laid down in "Forestry"; it is the intention to eventually cover the bare farm lands purchased at the Higby Reservoir, with a growth of trees that will have a commercial value for their timber qualities.

J. C. BROATCH.

Middletown, Conn.

We are laying here in Norfolk about four thousand feet of six-inch cast iron water pipe, about three thousand feet of which was completed last fall, the balance to be laid in the spring.

I know of no other work in this immediate vicinity. We have a very large water supply and were not affected by the scarcity scare of 1899.

EDMUND BROWN.

Norfolk, Conn.

During the past year I have made plans for a gravity water supply for Collinsville. The work is now held up by injunction by the Unionville people. This injunction will probably be removed shortly. I have also put in a system at Forestville, taking water from the Bristol Water Co., and placed a standpipe 30 by 36 feet in Bristol to regulate the pressure. It works very well. There is a pressure regulator in the main to Forestville, and this works well also.

I have made plans, which I understand are approved, for a storage reservoir in the town of Harwinton, and think we will build at once. Have been consulted and made plans for a number of small works, and had a number of flowage cases: the Plainville disaster case, which is somewhat in the nature of a flowage case, where, in the Connecticut courts we claim $5,000 for one life and in Massachusetts courts $45,000 for another. I have prepared as well some reports on water supply, and have one rather lengthy one which will probably be in print previous to the annual meeting.

HENRY W. AYRES.

Bristol, Conn.

Cast Iron Pipe Laid.

10 inch	13020	feet.
8 "	7981	"
6 "	16460	"
4 "	938	"
2 "	305.6	"

Valves Placed.

10 inch	6
8 "	12
6 "	29
4 "	9

Hydrants Placed.

Double	19
Single	4

ROSWELL ATKINS.

Bristol, Conn.

New Haven.

Lake Whitney furnishes the most water of any source of supply; rainfall at Lake Whitney from Dec. 1, 1900, to Dec. 1, 1901, 59.73 inches. 53 meters have been set during the year 1901.

Pipe Laid.

4″	1068 ft.,	New Haven.
6″	10766 "	"
8″	17370 "	"
10″	6650 "	West Haven.
12″	8272 "	New Haven.
16″	4102 "	"
24″	2478 "	"
6″	7000 "	West Haven.

Greenwich.

A decided increase in the number of meters installed as a result of the low condition of the supply in 1899.

Hartford.

As a result of the low condition of the city's supply in 1899 and 1900, active steps have been taken to prevent waste, both in the distribution and at the reservoirs.

Over 6,000 meters have been placed, their size and make being exhibited in the following table:

Size in inches.

Make.	½	⅝	¾	1	1½	2	3	4	6	Total.
Lambert	....	589	297	14	4	....	4	1	1	910
Trident	....	1460	1014	150	30	12	7	4	....	2677
Hersey	....	92	15	1	1	2	....	2	1	114
Thompson	8	206	111	74	53	28	18	12	1	511
Empire	....	1000	581	23	5	3	3	1	....	1616
Nash	....	97	1	....	....	....	....	....	....	98
Torrent	....	....	....	....	....	....	....	4	3	7
Gem	....	....	....	....	....	1	....	2	....	3
Terry	....	6	4	2	....	1	....	....	....	13
Worthington	....	....	1	....	....	2	1	....	....	4
Hartford	1	....	....	....	....	....	....	....	....	1
Undine	7	....	29	21	....	18	10	1	....	86
Union Meter Co.	....	2	....	....	1	....	....	....	....	3
Crown	....	1	....	....	1	....	....	....	....	2
Total	16	3453	2053	285	95	67	43	27	6	6045

At the reservoirs two lines of pipe have been laid as substitutes for side-hill canals: one 24 inch vitrified sewer pipe, 16,700 feet in length, between reservoirs 6 and 5; the other 24 inch cast iron, 9,400 feet in length between reservoirs 4 and 1.

STANDARD SPECIFICATIONS FOR CAST IRON PIPE.

The Committee on Water Supply is of the opinion that more cast iron pipe has been bought and laid in the State of Connecticut each year than is indicated by this report. There are many reasons why this is so now; but we hope that the time is coming when every ton of water pipe used in the State will be purchased under the advice and supervision of some of our members. All the engineers in the State should be members of our Society. Anyone who has the knowledge of what is needed and what can be obtained when cast iron pipes are to be bought, probably has the other qualifications required for membership. And our conduct of our affairs should be such that the purchasing public will come to have the belief that they will make a mistake if they go outside of our lines for advice in engineering matters.

At the present time it is the usual experience of an engineer when buying cast iron pipe—especially in any smaller quantity than several hundred tons—to find that he cannot obtain just what he thinks is the best. He is told by the pipe selling agents that some of the items of the specifications that are given in the books, or are in use by the engineers of large cities in their contracts for pipe, are impracticable, are just the notion of some engineer who is so situated that he can dictate as to what he will take, but of no real value, etc., etc., the result being that he can give his employer no better service than another, who can make no claim to the possession of the special knowledge of an engineer, and that he accepts pipe that are heavier in design and hence cost more than need be, or are inferior in quality and give much trouble from a lack of uniformity in the size of the pipes.

It is [illegible] that as a large part of the pipes used in this State are bought in rather small quantities, they are, as a rule, far below the best.

Wherever it is possible to do so engineers have found it to be an advantage to have standard designs and specifications.

It is thought that the members of this Society will, by adopting a Society standard of designs and specifications for cast iron pipe, be able to submit better advice to their clients than they can now, place themselves in a position such that their advice cannot be easily set aside by the pipe sellers, and thus make their services more valuable to their clients.

The New England Water Works Association has such standard specifications for cast iron pipe before it for consideration at this time. We would advise that our incoming President be instructed to appoint a committee who shall take up this matter at once, ascertain the present practice, and the wishes of all of our members interested, and to especially consider the work done by the N. E. W. W. Association, with the view of the adoption by our Society of their standards so far as possible, or with only slight changes, as they would thus be given more force and be of more benefit to our members than any entirely distinct action of our Society.

During the past two years two epidemics of typhoid fever have occurred in this State, the source of infection having been attributed to the water supply.

The first occurred at the village of Forestville in the town of Bristol, in the spring of 1900. By the breaking of the suction pipe to the pumps which supply the village, water was taken from a sewage-contaminated branch of the Pequabuck River, and delivered to the consumers. There were about fifty cases of typhoid fever attributed to the water supply, of which 14 per cent. were fatal.

The second was that which occurred in New Haven in April, 1901, 455 cases of typhoid fever being reported at the office of the Board of Health, the mortality being nearly 12 per cent. Through the courtesy of Dr. Wright, health officer, his report on the source of infection is herewith submitted.

William E. Johnson,
For Committee.

Report of Dr. Wright, April 18, 1901.

Mr. President and Gentlemen of the Board of Health:

I beg leave to call your attention to a number of cases of typhoid fever now prevailing in New Haven and lay before you a full report of the situation. On the morning of April 3 (last Wednesday), six cases of this disease were reported by two physicians, each reporting three cases. While this number is unusual for this season of the year, there seemed to be nothing to attract special attention, but during the latter part of the day repeated inquiries by physicians and the fact that an unusual number of blood specimens had been sent to the bacteriologist to have the Widal's test applied, excited my suspicion that we were on the verge of an outbreak of this disease. This was increased at a meeting of the New Haven Medical Association held the same evening, when many physicians stated that they were in attendance upon persons whom they suspected to be ill with the disease. The next morning I came to this office very early that I might find if more cases had been reported, and found eight new cases. The location of these cases and conversations by telephone with several physicians led me at once to believe the trouble was in the water supply, as all of the cases were in the western part of the city, extending north and east as far as Dixwell avenue and south and east as far as Congress and Howard avenues.

My next move was to telephone those physicians residing in the adjoining town whom I knew to be practicing in the vicinity of the storage lakes and along the streams leading to the same. Several cases were learned of in this way in different localities, but the only ones that could be regarded as likely to cause the outbreak were those happening in a German family living in Woodbridge, near the Bethany line and nearly a mile above Lake Dawson.

I at once consulted with Mr. Daggett, the secretary of the New Haven Water Company, and ascertained that the western part of the city was wholly supplied with water from this lake, and that the parts extending north and south to the lines above given were partially supplied from the same service, the quantity and distances depending upon the pressure in the pipes of the water from other lakes.

I immediately made an appointment with the physician who had been in attendance upon the Woodbridge cases, to visit the family. I wished him to accompany me, as I believed the people would talk more freely in his presence. As soon as possible, we drove out to the place, which is about eight or nine miles from the city. I found that there had been three persons sick with typhoid fever in the house. They had called the doctor to the first case January 27, and he had made but a few visits.

On March 4 he had been again called, and this time he found two more sick. He instructed the head of the family to bury the fecal discharges, and in carrying out the instructions, the man had taken them several hundred feet from the house and buried them, as I estimate from his description, about six or eight inches deep in plowed ground distributing over an area of at least 100 feet square and within 50 to 100 feet of a dry waterway. All of this was told to me in the presence of the physician and I believe the same to be true.

The next day, I am told by the officials of the Water Company, when four or five of them visited him, he said that he had buried the discharges in a very circumscribed area, and at a depth of two feet. This is at variance with his statements to me, and seems hardly probable, as there was more or less frost in the ground and the amount of care necessary to do this is not consistent with the general appearance of the premises.

On March 11 came the first heavy rainfall, and a few days later the second. Just when this fecal matter was washed away is only a conjecture, but that it was, is evidenced by the fact that the surface of the ground all around in the vicinity of the place where the discharges had been buried, had been excavated by the heavy rains, having furrows from three to six inches deep leading to the edge of the waterway, through which water could only escape in a direction leading directly to Lake Dawson.

Fortunately I was able to observe how large a quantity of water sometimes goes down this course, as it was raining heavily while I was there, and a stream several feet wide was running violently past at the time.

Upon my return home at about 5.30 P. M., I notified the secretary of the Water Company that I believed I had located the source of the infection, and that evening, by request, met the

President, Secretary and Dr. H. E. Smith, the chemical expert of the Water Company, and laid the facts as above stated before them, with the result that in my presence, and without a protest, the water from the lake was ordered shut off from the supply pipes and the waste gates opened.

The next day the pipes in the city containing water from this source were blown off. The only water from this lake now used is in about twenty houses in Westville, where it is impossible to supply other water, and the occupants of these houses have been warned of the danger of using this water without boiling. Within twenty-four hours of the first evidence of a serious outbreak of typhoid, the source of the infection had been, to my mind, definitely located, and steps had been taken to prevent further infection from this source.

On April 3 we had reported six cases; April 4, ten cases; April 5, thirty-six cases, and April 6 the same number. At the time of the presentation of this report there has been reported a total of 211 cases, and the diagnosis of typhoid fever in over seventy of these has been verified by Widal's test.

In addition to the above investigation we are, as fast as possible, ascertaining of each individual case, the water—whether city, well or spring—ice and milk supplies, whether or not the sick persons have eaten raw oysters or clams, celery or other uncooked vegtables, the sanitary condition of the premises, the condition of the plumbing, whether or not the sick one has been out of the city within three weeks of being taken ill, and finally, if proper instructions have been given in regard to the disinfection of the excreta.

It is to be expected, even if we have been so fortunate as to have properly located the source of the infection, that there will be many cases for at least two weeks, and there will be secondary cases in other parts of the city.

The waste gates of Lake Dawson have been open since very early in the morning of April 5, and I understand the lake should be emptied in two or three days. The heavy rains of the past few days have kept the lake full, notwithstanding the gates are open. The pond by this time must be pretty well flushed out, and any pathogenic material there must be pretty well diluted.

It is not in the province of your body to order how the lake or premises upon which the infection is assumed to originate.

shall be disinfected, but it is in your power to prevent the water being brought within the limits of New Haven until you are satisfied that such is free from infection.

As it is probable that pathogenic bacteria are destroyed by the common water bacteria within a few weeks, and that any disease-producing bacteria in this water are now largely diluted, I recommend that your honorable Board notify the New Haven Water Company that water from Lake Dawson cannot be supplied to consumers within the limits of New Haven until the water now in the lake has stood for at least one month and then drawn off and the lake filled with fresh water.

Respectfully submitted,

FRANK W. WRIGHT,
Health Officer.

REPORT OF THE COMMITTEE ON SEWERAGE.

HARTFORD, CONN., April 26, 1902.

To the President and Members of the Connecticut Society of Civil Engineers:

GENTLEMEN:—In taking up the work assigned to us for the year 1901, by the President of our Society, it was the opinion of the members of our committee that a slight deviation from the established practice of former committees on sewerage would do the Society no harm. It has been the custom of former committees to collect and tabulate, from the different members of our Society, the amount, size, material, and cost of all sewer construction under their supervision. While this detailed information is of great value to our President in making up his annual address to the members, and is no doubt of equal value to the Society as a matter of record, yet it is in our opinion of little practical value to members as a basis for making either reliable estimates or comparisons, due largely to the different conditions under which it is obtained and applied.

We, therefore, decided at the start to formulate a set of questions, the answers to which, if properly tabulated, we believed would be of great value to our members, and sent them out to the city or resident engineers of every town and city in Connecticut; to every city in Rhode Island and Massachusetts, whose population equalled or exceeded 20,000; and to several of the largest cities throughout the United States.

We have embodied under each question the answers as they were received, and arranged them alphabetically by states and cities.

We have made no attempt to draw any conclusions from these answers, knowing that each engineer, as he is called upon for information in his own field of usefulness, can formulate his own deductions from the answers to the questions which are applicable to his particular needs.

Respectfully submitted,

FREDERICK L. FORD, Hartford,
WM. H. CADWELL, New Britain,
CHARLES C. BROWN, Danbury,

Committee on Sewerage for the year 1901.

The questions were as follows:

1. Population of census of 1900?
2. Approximate miles of brick and tile sewers?
3. Are your sewers built by the city or by the contract system?
4. If built by contract, how much of the material used in construction is furnished by city?
5. If sewers are built by contract, how long does the contractor maintain the work?
6. Do you have a laboratory for testing materials used in sewer construction?
7. What is the diameter of the largest vitrified sewer which you built?
8. Are your sewers underdrained?
9. Do you lay house connection laterals back to the curb or fence lines, when the main sewers are built, to avoid tearing up the street at a later date, or simply build Y branches where connections will probably be needed in the future?
10. When property owners wish to connect with the main sewer, under what terms and restrictions is the work done?
11. If this work is done by licensed drain layers, to what extent does the city furnish engineering and inspection?

12. What qualifications are required of inspectors on sewer work, and what prices per day are paid?

13. To whom, or to what account, are these inspectors' wages charged?

14. Does your city bear the whole or any part of the cost of sewer construction?

15. How is the amount assessed against abutting property proportioned and levied?

16. What conditions are made regarding the time allowed for the payment of sewer assessments, and what discount allowed for prompt payment?

17. Please explain your practice in making sewer assessments?

18. How is the annual maintenance of the system provided for?

19. Do you favor making the sewer system self-supporting by some method of direct tax similar to water systems?

20. Has your city adopted, or do they contemplate the adoption of sewage rentals?

21. Does your sewer department have a permanent chairman?

22. Does your sewer department keep an authentic record of rainfall, for protection of the city in suits, etc.?

23. Is your method of sewer assessments satisfactory?

1. Population of Census of 1900?

CONNECTICUT.

Ansonia	12,681
Bethel	3,327
Bridgeport	70,996
Bristol	9,643
Danbury	16,850
Derby	7,930
East Hartford	6,406
Farmington	3,313
Granby	1,299
Greenwich, in Borough	2,500
Hartford	79,850
Litchfield	3,214
Meriden	28,695
Middletown, City	12,000
" Town	17,486
Naugatuck	10,541
New Britain	25,998
New Haven	108,827
New London	17,548
New Milford	4,804
Norfolk	1,614
(Larger transient summer population.)	
Norwalk, City	6,000
" Town	19,932
Norwich	17,251
Putnam	7,348
Ridgefield	2,626

Rockville, in town	8,483
Shelton "	5.572
Simsbury	2.094
South Manchester, in town	1.061
South Norwalk, part of town of Norwalk.	
Stafford Springs, in town	4.297
Stamford	18,830
Torrington	12.453
Wallingford	7.000
" Borough	9.001
Waterbury	45.868
Willimantic, Town	10.137

MASSACHUSETTS.

Boston	560.892
Brockton	40.063
Brookline	19.935
Winter population about	21.500
Cambridge	91.886
Everett	24.336
Fall River	104.863
Fitchburg	31.531
Gloucester	26.121
Haverhill	37.175
Holyoke	45.712
Hyde Park	13.000
Lawrence	62.559
Lowell	94.969
Lynn	68.513
Malden	34.365
New Bedford	62.442
Newton	33.587
North Adams	24.200
Quincy	23.889
Somerville	61.643
Springfield	62.059
Taunton	31.036
Waltham	23.481
Worcester	118.421

RHODE ISLAND.

Newport	22.000
Pawtucket	39.231
Providence	175.597
Woonsocket	28.200

OTHER STATES.

Albany, N. Y.	94.151
Baltimore, Md.	508.957
Buffalo, N. Y.	352.387
Cincinnati, O.	326.000
Chicago, Ill.	1.700.000
Cleveland, O.	381.768
Columbus, O.	125.560
Detroit, Mich.	285.704
Minneapolis, Minn.	202.718
Newark, N. J.	246.070
New York City, N. Y.	3.437.202
Philadelphia, Pa.	1,293.697
Rochester, N. Y.	162.608
St. Louis, Mo.	575.000
St. Paul, Minn.	163.700
San Francisco, Cal.	342.762
Washington, D. C.	278.718

2. Approximate miles of brick and tile sewers?

CONNECTICUT.

Ansonia	No replies received.
Bethel	Only a few feet of surface water drains.
Bridgeport	4 Brick, 74 Tile.
Bristol	8 Tile.
Danbury	5 Brick, 7 Tile.
Derby	No replies received.
East Hartford	0.5 Brick, 9 Tile.
Farmington	3 Tile.
Granby	0.7 Tile.
Greenwich	9 Tile.
Hartford	92.5 Brick and Tile.
Litchfield	No replies received.
Meriden	2.21 Brick, 27.39 Tile, 0.93 Iron.
Middletown	2.1 Brick, 10.3 Tile.
Naugatuck	2 Tile.
New Britain	9.53 Brick, 19.43 Tile.
New Haven	40 Brick, 59 Tile.
New London	0.14 Brick, 17.7 Tile.
New Milford	No replies received.
Norfolk	6 Tile.
Norwalk	1.25 Brick, 11.75 Tile.
Norwich	2.5 Brick, 11 Tile.
Putnam	No replies received.
Ridgefield	9 Tile.
Rockville	2 Brick, 16 Tile.
Shelton	No replies received.
Simsbury	1 Tile, 0.75 Iron Pipe.
South Manchester	No replies received.
South Norwalk	0.5 Brick, 11 Tile.
Stafford Springs	No replies received.
Stamford	Not answered.
Torrington	No replies received.
Wallingford	0 Brick, 12 Tile.
Waterbury	No replies received.

MASSACHUSETTS.

Boston	551.87 Brick and Tile.
Brockton	Not answered.
Brookline	8 Brick, 46 Tile.
Cambridge	Not answered.
Everett	3 Brick, 32 Tile.
Fall River	0.5039 Brick, 3.6406 Pipe.
Fitchburg	4.37 Brick, 26.94 Tile.
Gloucester	Has no sewerage system.

Haverhill	6.8 Brick, 29.8 Tile.
Holyoke	10 or 12 Brick, 20 Tile.
Hyde Park	16 Pipe.
Lawrence	19.5 Brick, 34 Tile.
Lowell	29 Brick, 56 Tile.
Lynn	12.3 Brick, 52.7 Tile.
Malden	1.5 Brick, 43 Tile.
New Bedford	17 Brick, 46 Tile.
Newton	13.05 Brick, 76.03 Tile.
North Adams	0.25 Brick, 27.3 Tile and Iron.
Quincy	1.9 Brick, 25 Tile.
Somerville	80.7 Sewers and Drains.
Springfield	25.28 Brick, 69.34 Tile.
Taunton	8.35 Brick, 13.09 Tile.
Waltham	1.83 Brick, 36.29 Tile.
Worcester	157.50 both.

RHODE ISLAND.

Newport	No record.
Pawtucket	7.72 Brick, 38.96 Tile.
Providence	57.73 Brick, 122.68 Tile.
Woonsocket	1.6 Brick, 9.6 Pipe.

OTHER STATES.

Albany	46.2 Brick and Stone, 45 Tile.
Baltimore	28.6 Brick, 3.9 Tile.
Buffalo	140 Brick, 276 Tile.
Cincinnati	57 Brick, 104 Tile.
Chicago	550 Brick, 950 Tile.
Cleveland	281 both.
Columbus	68.4 Brick, 75.2 Tile.
Detroit	345¾ Brick, 100 Tile.
Minneapolis	92.7 Brick, 63.4 Tile.
Newark	65 Brick, 96.5 Tile.
New York City	496.04 both.
Philadelphia	928 both.
Rochester	21.20 Brick, 120.50 Tile, 74.70 Stone.
St. Louis	220.55 Brick, 257.03 Tile.
St. Paul	21 Brick, 124 Tile.
San Francisco	110 Brick, 202 Tile.
Washington	92 Brick, 328 Tile.

3. Are your sewers built by the city or by the contract system?

CONNECTICUT.

Bridgeport	By contract.
Bristol	By contract.
Danbury	By contract.
East Hartford	By contract.
Farmington	By contract.
Greenwich	By contract.
Hartford	By contract.
Meriden	By city.
Middletown	By city.
Naugatuck	Both.
New Britain	By city.
New Haven	By contract.
New London	Both.
Norfolk	By contract.
Norwalk	By contract.
Norwich	Early by contract; recent by city.
Ridgefield	By contract.
Rockville	By contract.
Simsbury	By contract.
South Norwalk	By contract.
Stamford	Early by contract; recent by city.
Wallingford	By contract. Some sewers were built by city, but were expensive and very unsatisfactory.
Waterbury	By contract.

MASSACHUSETTS.

Boston	Both.
Brockton	Before 1896 by contract. Since by city.
Brookline	By contract.
Cambridge	By city.
Everett	Before 1897 by contract. Since by city.
Fall River	By city.
Fitchburg	By city.
Haverhill	By city for over 10 years.
Holyoke	Some of the larger sewers were built by contract; all other by city.
Hyde Park	By contract.
Lawrence	Mostly by city. Occasionally by contract.
Lowell	By city.
Lynn	Both.
Malden	Both contract and day labor.
New Bedford	By city.
Newton	First part of system by contract. Extensions now built by city.

NORTH ADAMS	By city.
QUINCY	Both.
SOMERVILLE	By contract.
SPRINGFIELD	Tile sewers by city. Brick by contract and city.
TAUNTON	At present by contract. Before 1899 by city—generally.
WALTHAM	Both. By city for last 8 years.
WORCESTER	By city.

RHODE ISLAND.

NEWPORT	By city.
PAWTUCKET	By city.
PROVIDENCE	By contract.
WOONSOCKET	Both. All trunk sewers by contract.

OTHER STATES.

ALBANY	By contract.
BALTIMORE	Both.
BUFFALO	By contract.
CINCINNATI	By contract.
CHICAGO	By contract (except intercepting sewers).
CLEVELAND	By contract.
COLUMBUS	By contract.
DETROIT	By contract.
MINNEAPOLIS	By city since 1886.
NEWARK	By contract.
NEW YORK CITY	By contract.
PHILADELPHIA	By contract.
ROCHESTER	By contract.
ST. LOUIS	By contract.
ST. PAUL	By contract.
SAN FRANCISCO	By contract.
WASHINGTON	Both.

4. If built by contract, how much of the material used in construction is furnished by city?

CONNECTICUT.

[illegible]	Iron work of manholes and catch basins.
[illegible]	None.
[illegible]	None.
[illegible]	Castings for manholes and flush tanks.
[illegible]	None.
[illegible]	Built by association similar to Simsbury.
[illegible]	None.
[illegible]	None.

Meriden	Materials contracted for delivered on work, all labor, etc., by city.
Naugatuck	Pipe, manhole and inspection caps.
New Haven	Granite basin stone for catch basins, cast-iron manhole heads and covers, and catch basin pans and gratings.
New London	All iron work, and sometimes the pipe.
Norfolk	All material.
Norwalk	None.
Ridgefield	The pipes and castings.
Rockville	Brick, tile, cement and castings.
Simsbury	None.
South Norwalk	None.
Stamford	When work was done by contract city furnished pipe.
Wallingford	None.
Waterbury	Iron work only in manholes and catch basins.

MASSACHUSETTS.

Boston	Practically all—sand, lumber and small supplies excepted.
Brockton	Castings, pipe, brick and cement.
Brookline	Castings, pipe, brick and cement usually.
Everett	All material was furnished by city.
Holyoke	None.
Hyde Park	Vitrified pipe and iron castings. When Portland cement is needed town specifies brand and pays excess cost over Rosendale.
Lawrence	When built by contract, city furnishes nothing.
Lynn	None.
Malden	Everything, except sand and gravel or broken stone.
Newton	Pipe, brick, cement and castings.
Quincy	All.
Somerville	Castings and Akron pipe.
Springfield	None.
Taunton	All, except sand and gravel.

RHODE ISLAND.

Providence	Brick, pipe, cement, flagstone and iron work.
Woonsocket	All except sand.

OTHER STATES.

Albany	None.
Baltimore	None.
Buffalo	None.
Cincinnati	None.

Chicago	None.
Cleveland	None.
Columbus	None as a rule. In 1892 part of brick furnished by city. Result—Dispute with contractor and law-suits not yet concluded.
Detroit	Cement and manhole covers.
Minneapolis	When built by contract, castings.
Newark	No materials. I would consider it a better plan for the city to purchase the principal materials, if it was known at the beginning of the year what improvements were to be made during the ensuing year, but most work is done by petitions from time to time.
New York City	None.
Philadelphia	None.
Rochester	None.
St. Louis	None.
St. Paul	None.
San Francisco	None.
Washington	Cement, invert blocks, vitrified bricks, pipes and castings.

5. If sewers are built by contract, how long does the contractor maintain the work?

CONNECTICUT.

Bridgeport	Until finished.
Bristol	Two months from date of final completion.
Danbury	Six months. It is in a measure determined by the City Engineer.
East Hartford	Six months.
Farmington	One year.
Greenwich	Six months.
Hartford	Until City Engineer is satisfied with condition of street, not less than three months from date of completion.
Naugatuck	Sixty days.
New Haven	Six months.
New London	Six months.
Norfolk	About one year.
Norwalk	Three to six months.
Ridgefield	Two months.
Rockville	Six months.
Simsbury	Thirty days.
South Norwalk	Generally ninety days.
Stamford	Generally five years.
Wallingford	Six months.
Waterbury	Six months.

MASSACHUSETTS.

Boston	Six months after completion.
Brockton	Six months.
Brookline	Not after work is accepted.
Everett	Six months.
Holyoke	After work is accepted by city the contractor is relieved from all responsibility.
Hyde Park	Work, if satisfactory, is accepted 30 days after completion. Contractor is required to maintain or repair surface of streets for six months, exclusive of winter months.
Lawrence	No maintenance clause in specifications. Contractor is relieved when work is accepted.
Lynn	Six months.
Malden	Six months.
Newton	Six months.
Quincy	Six months after completion.
Somerville	Six months after completion.
Springfield	One year.
Taunton	On last contract from November to May.
Waltham	Not after completion.

RHODE ISLAND.

Providence	Six months.
Woonsocket	Six months after acceptance.

OTHER STATES.

Albany	One year.
Baltimore	One to two years.
Buffalo	Six months, excluding December to May, inclusive.
Cincinnati	Streets disturbed two years.
Chicago	One year.
Cleveland	Four months.
Columbus	Usually two years. 10% of contract price retained, one-half of which paid one year after completion, balance two years after completion.
Detroit	No fixed time.
Minneapolis	Not after final accceptance.
Newark	For one year under certified check for 5% of final payment.
New York City	Six months.
Philadelphia	Three years, paving one year.
Rochester	One year.
St. Louis	One year.
St. Paul	Six months.
San Francisco	Not after completion.
Washington	Five years.

6. Do you have a Laboratory for testing materials used in sewer construction?

CONNECTICUT.

Bridgeport	No.
Bristol	No.
Danbury	No.
East Hartford	An unsatisfactory one.
Farmington	No.
Greenwich	No.
Hartford	No.
Meriden	No.
Middletown	No.
Naugatuck	No.
New Britain	No.
New Haven	Test cement only.
New London	No.
Norfolk	No.
Norwalk	No, not a regular laboratory.
Norwich	No.
Ridgefield	No.
Rockville	No.
Simsbury	No.
South Norwalk	No.
Stamford	No.
Wallingford	No.
Waterbury	For cement testing.

MASSACHUSETTS.

Boston	For cement testing.
Brockton	Cement tester and brick absorption.
Brookline	For cement testing.
Cambridge	No.
Everett	Occasionally [illegible] cement.
Fall River	No.
Fitchburg	No.
[illegible]	No.
[illegible]	[illegible] cement [illegible] Riehle machine.
Hyde Park	No.
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	No.
[illegible]	[illegible]
[illegible]	No. We do not always ask for proposals for materials. [illegible] some bidders are restricted to certain well kno brands of cement, pipe and brick.
[illegible]	No.

Somerville	Cement and bricks tested.
Springfield	For cement testing.
Taunton	Cement tester only.
Waltham	Yes.
Worcester	Yes.

RHODE ISLAND.

Newport	No.
Pawtucket	For testing cement.
Providence	For testing cement.
Woonsocket	No.

OTHER STATES.

Albany	For testing cement.
Baltimore	Yes.
Buffalo	Yes.
Cincinnati	For testing cement.
Chicago	For testing cement.
Cleveland	Yes.
Columbus	For testing cement and absorption of brick.
Detroit	No.
Minneapolis	Yes.
Newark	No laboratory. Tests made when required.
New York City	For testing cement.
Philadelphia	Laboratory equipped for all tests.
Rochester	For testing cement.
St. Louis	For testing cement and vitrified brick.
St. Paul	For testing cement.
San Francisco	Yes.
Washington	Yes.

7. What is the diameter of the largest vitrified sewer which you build?

CONNECTICUT.

Bridgeport	14" x 21" hub joint cement.
Bristol	24"
Danbury	18"—surface water 30"
East Hartford	30"
Farmington	12"
Greenwich	24"
Hartford	24"
Meriden	24"
Middletown	24"
Naugatuck	15" so far.
New Britain	24"

New Haven	18"
New London	24"
Norfolk	12"
Norwalk	24"
Norwich	24"
Ridgefield	15"
Rockville	24"
Simsbury	8"
South Norwalk	24"
Stamford	18"
Wallingford	30"
Waterbury	24"

MASSACHUSETTS.

Boston	30" for surface water sewers. 24" for house sewers.
Brockton	24"
Brookline	18"
Cambridge	Use now nothing above 15"
Everett	18"
Fall River	24"
Fitchburg	20"
Haverhill	24"
Holyoke	24"
Hyde Park	24"
Lawrence	Nothing now larger than 18"
Lowell	24"
Lynn	24"
Malden	20", reinforced with concrete.
New Bedford	24"
Newton	24
North Adams	24" Probably will not recommend any more as large.
Quincy	24
Somerville	30" Akron pipe.
Springfield	24"
Taunton	24
Waltham	24 [illegible] size. Would not use now anything larger than 18"
Worcester	24 [illegible] concrete

RHODE ISLAND.

Newport	24"
Providence	Have built 24". Doubt if I should in the future buil[illegible] over 18".
Woonsocket	24"

OTHER STATES.

Albany	36" largest already laid. No objection to larger sizes.
Baltimore	30"
Buffalo	30"
Cincinnati	24"
Chicago	18" and little of that.
Cleveland	18"
Columbus	24", but usually prefer brick in sewers of this size.
Detroit	24"
Minneapolis	24"
Newark	30"
New York City	15"
Philadelphia	18"
Rochester	24"
St. Louis	Have used 30", but do not now use more than 24"
St. Paul	24"
San Francisco	24"
Washington	24"

8. Are your sewers underdrained?

CONNECTICUT.

Bridgeport	No.
Bristol	About four miles of underdrains.
Danbury	Not as a rule.
East Hartford	No, except in one instance.
Farmington	No.
Greenwich	No.
Hartford	No.
Meriden	Somewhat.
Middletown	No.
Naugatuck	No.
New Britain	No.
New Haven	No.
New London	Sometimes.
Norfolk	Not to any extent.
Norwalk	No.
Norwich	Some of them.
Ridgefield	Some of them.
Rockville	Not generally.
Simsbury	No.
South Norwalk	No.
Stamford	No.
Wallingford	About 6,000 feet, by drain laid at side of trench 6" below grade of main sewer—results very satisfactory.
Waterbury	In very wet places.

MASSACHUSETTS.

Boston	When necessary.
Brockton	Whenever there is water in the ground.
Brookline	When needed to get tight work.
Cambridge	Many of the larger ones, but only for construction.
Everett	In wet trenches lay 4-inch drain and plug it on completion of the work.
Fall River	Some are—some are not.
Fitchburg	No.
Haverhill	A few on separate system recently adopted for an outlying district.
Holyoke	No.
Hyde Park	Yes, where water was found.
Lawrence	No.
Lowell	Not generally.
Lynn	Some, both of tile and brick sewers.
Malden	Yes, but not permanently.
New Bedford	No. Under large brick sewers often lay 6" drain for construction purposes only.
Newton	Yes.
North Adams	No.
Quincy	Only where necessary during construction.
Somerville	Separate system sewers are underdrained.
Springfield	They are where a considerable amount of ground water is present.
Taunton	Where necessary if possible.
Waltham	Partially—In wet soil.
Worcester	A few.

RHODE ISLAND.

Newport	No.
Pawtucket	Two or three, where it was necessary.
Providence	Not as a regular practice.
Woonsocket	Yes, where necessary.

OTHER STATES.

Albany	No.
Baltimore	No.
Buffalo	A few.
Cincinnati	In some cases. Generally not.
Chicago	No.
Cleveland	Sometimes.
Columbus	Not as a rule.
Detroit	Only in a few instances.
Minneapolis	Only a few.
Newark	Where necessary.

New York City	No.
Philadelphia	No.
Rochester	No, except some of the large brick sewers.
St. Louis	Some of them; wherever soil is very wet.
St. Paul	No.
San Francisco	No.
Washington	Yes, if required.

9. Do you lay house connection laterals back to the curb or fence lines when the main sewers are built, to avoid tearing up the street at a later date, or simply build Y branches where connections will probably be needed in the future?

CONNECTICUT.

Bridgeport	Build branches 6 inches long on brick sewers, none on cement.
Bristol	Y branches only.
Danbury	Usually Ys only, except on streets that have been set aside for macadam, when the connection is laid to curb.
East Hartford	Y branches only.
Farmington	Y branches only.
Greenwich	Y branches only.
Hartford	6" connections to curb lines.
Meriden	Y branches about every 30 feet on each side.
Middletown	Y branches only.
Naugatuck	Whenever it is proposed to macadam or pave street.
New Britain	Y branches only.
New Haven	Y branches only. Where pavements are about to be laid the property owners are ordered to make connections, at least to the curb, sufficient for all probable needs.
New London	Y branches only.
Norfolk	Y branches only.
Norwalk	Y branches only, except when streets are to be paved with block, brick or asphalt, when connections are laid to curb, usually the fall before paving is done.
Norwich	Y branches only.
Ridgefield	Y branches only.
Rockville	Y branches only.
Simsbury	Y branches only.
South Norwalk	Y branches only, except where street is to be soon paved with brick.
Stamford	Y branches only.
Wallingford	Y branches only.
Waterbury	Y branches only, 20 feet apart each side.

MASSACHUSETTS.

Boston	Ordinarily Y branches every 25 feet, but there is a class of work where street is built in accordance with act of legislature and closed to work for two years on which laterals are built one foot inside of curb to sidewalk.
Brockton	Y branches only.
Brookline	Y branches only.
Cambridge	Y branches only unless street is shortly to be paved.
Everett	Y branches only; when street is ordered macadamized, abuttors are notified to make connections previous to commencement of work.
Fall River	Y branches only. Usually about 25 feet apart.
Fitchburg	Y branches only.
Haverhill	Y branches only.
Holyoke	In streets which are built up the abuttors supply a length or two of lateral pipe and the city furnishes a Y. For undeveloped land, sewer is built without Ys. I think the idea of laying laterals to curb line a good one where building lots are defined.
Hyde Park	Lay 5-inch T branches wherever connections will probably be needed, investigating the buildings as construction progresses.
Lawrence	Y branches only.
Lowell	Y branches only. When macadam or other pavement is to be laid, sewer connections, as well as water and gas services, must be laid to within 2 feet of sidewalk, or city will do it at expense of property.
Lynn	Connections laid to curb line, except in very narrow street.
Malden	Y branches only—about 25 feet apart.
New Bedford	Y branches only, except in a few streets paved over concrete foundation, where laterals were laid to curb lines.
Newton	T branches, every 25 feet.
North Adams	Y branches only, except on streets macadamized or to be paved, where laterals are laid to curb line.
Quincy	Y branches only.
Somerville	Y branches only generally, laterals very seldom.
Springfield	Y branches only, usually.
Taunton	Y branches only. When "permanent pavement" is contemplated connections are then laid to sidewalk.
Waltham	Y branches only. Do not believe in two separate jobs, as it practically makes impossible what is absolutely necessary if laterals are to be properly maintained, viz.: straight lines and straight grades, with manholes at all angles. With efficient workmen and in larger sewers have found that the best connections can be made with an opening cut into main sewer pipe for each connection.
Worcester	Have laid laterals to curb in a few streets to be paved.

RHODE ISLAND.

Newport	Y branches only.
Pawtucket	Y branches only.
Providence	To curb line since 1894.
Woonsocket	Generally Y branches only. In one case, laterals to curb lines charged direct to property.

OTHER STATES.

Albany	Laterals to point 1 foot within curb lines.
Baltimore	No system for house drainage—only sewers carry natural water courses.
Buffalo	Y branches, if street is not to be paved soon after sewer is constructed.
Cincinnati	Y branches only, except in few cases.
Chicago	Y branches when main is laid, and later lay drains to curb before street is paved.
Cleveland	Y's only, but believe connections should be laid to curb.
Columbus	Most sewers built in alleys in rear. A few sewers built in streets recently have connections to curb line.
Detroit	Y branches only.
Minneapolis	Y branches only, except when street is to be paved, when connections are laid to curb line.
Newark	Y branches only, except when street is to be paved, when connections are laid to curb line.
New York City	Branches only—every 12 feet.
Philadelphia	Laterals to curb line built as appurtenances of sewers.
Rochester	Laterals to curb, either when sewer is built or at putting down new pavement.
St. Louis	Branches only.
St. Paul	Y branches only, except when street is paved at same time.
San Francisco	Y branches only.
Washington	Neither.

10. When property owners wish to connect with the main sewer, under what terms and restrictions is the work done?

CONNECTICUT.

Bridgeport	None.
Bristol	Under supervision of sewer superintendent.
Danbury	No connections without a permit from the Superintendent of Public Works. The first joint is made under the City Engineer's direction or supervision, and property owner agrees to keep ditch in good shape for one year.

EAST HARTFORD	Work to be done by licensed drain layer. True grade from street line to sewer. Minimum fall 10" to 50'.
FARMINGTON	Inspection by the Borough Inspector.
GREENWICH	Only to put the street back in proper shape. No inspection.
HARTFORD	Applicant signs an agreement to conform to city laws and orders of inspector, and to properly restore street surface. City Engineer issues permit, locates slant, and inspects tapping and actual connection on old sewers where no slants or house connections were built.
MERIDEN	By application to City Engineer, who issues permit to licensed party. The City Engineer then locates slant, keeping a diagram record of its location from sewer to house.
MIDDLETOWN	A license has to be secured from the Street Committee of the Court of Common Council, after which the City Engineer locates and supervises the connection.
NAUGATUCK	By licensed plumber, on approval of Warden. Permit issued by Engineer. Fee on paved or macadam streets, $10, other streets, $2.
NEW BRITAIN	They must get permit from Sewer Board before connecting, and connection with sewer must be inspected by Clerk of Board.
NEW HAVEN	Work must be done by licensed plumbers, a fee of $1.50 being charged for opening street. In case of brick or asphalt pavement plumber pays cost of replacing pavement. In a few streets where no assessment on abutting property was made, the sewers having been built before plan of assessment was established, a fee of from $50 to $200 is demanded, according to intended use of connection.
NEW LONDON	On application of property, permit is granted to licensed drain layer, provided plumbing is in accordance with rules.
NORFOLK	Construction must be done by some authorized contractor.
NORWALK	A $5.00 connection fee is charged in each instance. The work is performed under the direction of the Sewer Inspector, who is appointed each year by the Council, and whose duties are to superintend the construction of new sewers, to keep the sewers in good condition, make repairs, etc., and to inspect the work of connection laying.
NORWICH	A licensed drain layer, who is under bonds to obey rules, makes application to connect, giving name of property owner, etc., and proposed size of drain. A set of rules

	regarding quality of material and workmanship, etc., is printed on license. "Drain layers shall make full written returns to the Board of Sewer Commissioners within 48 hours after completion of work, giving size, material, location and grade of the whole length of the pipes laid, and enumerate the fixtures connected therewith."
Ridgefield	Rules for connecting not yet decided on.
Rockville	Work must be done by licensed drain layers.
Simsbury	Work done under an inspector.
South Norwalk	Street not opened without permit from city, and work must be performed to the satisfaction of City Inspector.
Stamford	Owner pays cost of work, which is done under supervision of Sewer Inspector.
Wallingford	Permission to connect given by Court of Burgesses to licensed drain layers.
Waterbury	Permits issued, without charge, to licensed plumbers only. Charge by street depth for opening street.

MASSACHUSETTS.

Boston	Six-inch connection the minimum. To be done by licensed drain layer.
Brockton	Work done entirely by city to inside of cellar wall, and entire cost paid by property owner.
Brookline	Must be done by licensed drain layers.
Cambridge	Work must be done under permit, by licensed drain layer, under $200 bonds, who shall return permit to City Engineer's office, indorsed with a statement of his proceedings thereunder.
Everett	Drain layers licensed under $1,000 bonds. They make application to clerk of Department of Public Works.
Fall River	City Engineer issues permit to licensed drain layer, who is under $2,000 bond. Work done under supervision of City Engineer.
Fitchburg	They agree to pay all legal assessments and maintain the street excavated for one year. Most connections are made by city laborers, including all digging.
Haverhill	All connections made by licensed drain layers, who are under bonds to replace street satisfactorily, etc.
Holyoke	Where there are no Y branches city does the work and charges a fee for entering. Experienced men only are employed on this work. The Superintendent of Outdoor Work has full charge of the sewers, inspection, etc.
Hyde Park	Owner, agent, occupant or lessee signs a very complete application blank, and deposits $25. Engineer then estimates probable cost of connection, from main

	sewer to house wall—if over $25, applicant deposits excess. Work is then done by a local contractor, under direction of Engineer to the Board of Sewer Commissioners. City furnishes 5" pipe at 10 cents per foot, makes a small charge for engineering and inspection, and pays contractor 45 cents per lineal foot and $3.00 per cubic yard for rock excavation. Applicant pays actual cost on this basis, difference between estimated and actual cost being paid by parties debtor. If connection ever becomes clogged, owner must repair it, or city will at owner's expense.
LAWRENCE	Owner signs application for permit, which is given by City Clerk, to drain layer on his signing agreement to obey ordinances. This is taken to Superintendent of Streets, for slant, location, etc.
LOWELL	Signer of application for permit agrees to pay any cost to city resulting from his entering sewer or occupying street. City inspects whole connection.
LYNN	City requires:—payment of sewer assessment; work to be inspected by Inspector of Plumbing; to be laid either by Board of Public Works or by licensed drain layer.
MALDEN	Work must be done by a licensed drain layer, who applies for permit, and returns same, on completion of work, with his signature, certifying that connection was properly made.
NEW BEDFORD	Property owner first applies to Board of Health to enter sewer, then to Board of Public Works, who have sole jurisdiction over sewer construction and who are the only parties that can lay drains within the lines of the street. If property has been assessed for cost of sewer the owner then deposits with city treasurer an amount sufficient to pay cost of drain as determined by City Engineer. Any excess is returned. If no assessment has been paid by property, as in case of trunk sewers, an entrance fee, varying from $15 to $25, is charged in addition to cost of laying drain.
NEWTON	Owner signs application for connection, which is made by city at his expense. He either deposits estimated cost in advance, or applies to have it added on to his regular tax bill as with apportioned sewer assessments.
NORTH ADAMS	Application is made to Department of Public Works, and entrance fee or assessment paid. City lays that part of connection within street lines, charging cost to property owner. Remainder laid by licensed plumbers.
QUINCY	Owner makes application, stating number of fixtures he desires to connect. Board of Sewerage Commissioners then ask inspector of plumbing if fixtures in

	house are in proper shape to be connected to sewer, and upon his certificate that they are, they proceed to lay whole connection, and assess actual cost to owner. Bill collected like any sewer assessment, or may be apportioned into three annual payments.
Somerville	Must take out permit, and employ only licensed drain layers.
Springfield	Application is made to Mayor and Aldermen, when permit is given and fee paid to City Treasurer. Connection between sewer and street line is made by Superintendent of Streets and Sewers at expense of owner. Work upon private property performed by owner under regulations and inspection of Board of Health Department.
Taunton	Must employ licensed drain layer, use deep and wide socket pipe not less than five inches in diameter, and pack joints with jute before cementing.
Waltham	Pay in advance $15 for street work, plus estimated cost of sewer work. Final settlement after completion. Least grade 2%. Straight lines and grades. Manholes at all angles. Clean out in cellar suitable for inserting sewer cleaning apparatus, etc.
Worcester	Work done by licensed drain layers, subject to rules of Sewer Department.

RHODE ISLAND.

Newport	Work done by drain layers under $1,000 bonds, as guarantee for good work.
Pawtucket	Work done by licensed drain layers after application by owner, agreeing to pay costs of repairs and damages.
Providence	An application is signed in duplicate, relinquishing all claims for damage, stating what is to be connected, etc.
Woonsocket	Connections made by licensed drain layers or by city at actual cost, owner paying for whole connection from sewer to house. All under direction and inspection of City Engineer.

OTHER STATES.

Albany	Permit must be obtained from Commissioner of Public Works.
Baltimore	Work done under inspector, who sees that connection is properly made.
Buffalo	Work done by licensed plumbers under inspection of City Engineer.

CINCINNATI	$5 license fee, sewer assessment if any, and all costs of construction to be paid by owner, and work to be done by licensed drain layer.
CHICAGO	$5 fee charged for permit, to licensed drain layer.
CLEVELAND	Work must be done by licensed sewer builder under permit.
COLUMBUS	Must be made by licensed sewer builder, under $500 bond. Fee for permit $1.
DETROIT	Fee of $1 is charged. Additional charge for inspection to cover cost of same. Connection is made by Department of Public Works.
MINNEAPOLIS	Only licensed plumbers can do this work. Permit is issued on application, and deposit of money made with the City Treasurer, sufficient to cover estimated expense for inspection and any paving which may be disturbed. Ditch must be open from sewer to curb line and pipes laid on a uniform grade of ¼ inch per foot or over. Six-inch pipes are used; in special cases a larger pipe may be allowed.
NEWARK	Health Department issued permit to a licensed person, on behalf of property owner, which is filed in office of Superintendent of Sewers, who then issues permit, upon paying the sum of $10, for tapping an ordinary sized building on regular city lot, 25 x 100.
NEW YORK CITY	Work must be done by licensed plumber, who obtains permit from Sewer Department upon payment of a fee.
PHILADELPHIA	The cost for permit pays for the work of repaving by the city over trench. All connections are inspected by an official inspector.
ROCHESTER	Must obtain permit from Department of Public Works, and have work done by licensed plumber or drain layer.
ST. LOUIS	Permit must be obtained from Sewer Department and work inspected by city.
ST. PAUL	Make application to City Engineer, and deposit and pay $3 for each connection.
SAN FRANCISCO	Work done by Board of Public Works. Deposit required to cover cost.
WASHINGTON	Permits are issued to registered plumbers, who are required to maintain a deposit from which pavement repairs are made by city.

11. If this work is done by licensed drain layers, to what extent does the city furnish engineering and inspection?

CONNECTICUT.

East Hartford	Inspector is not necessarily present, except when connection is made with main sewer.
Meriden	City furnishes slant, location and inspection at time actual inspection is made with sewer.
Middletown	The City Engineer or Assistant Engineer engineers and inspects the work.
Naugatuck	Permit fee of $2 to cover same. Main sewer opened only in presence of Engineer.
New Haven	Some one from City Engineer's office must inspect and return the record of each connection. Inspectors of excavations look after the refilling of the trench.
New London	All work done under inspection.
Norfolk	Have no paid inspectors, but district executive committee are in supervision.
Norwalk	The work is done by licensed parties, and the city pays the inspector.
Norwich	The Sewer Inspector, appointed by Board of Street and Sewer Commissioners, is responsible for condition of whole work.
Rockville	Superintendent of Public Works simply views the connection and street sewer.
Wallingford	An inspector appointed annually by Court of Burgesses is required to inspect all connections.
Waterbury	Work done according to regulations and regularly inspected.

MASSACHUSETTS.

Boston	Inspection only made of connection with sewer. Inspector of Plumbing passes on everything in building and 10 feet outside of wall. Between those points there is no inspection, which is found to be a serious defect.
Brookline	It has been the practice to inspect connection and perhaps one pipe, but will probably adopt a rule by which inspection will be continued to the house.
Cambridge	No engineering, but drain is inspected as far as fence line.
Everett	Drain layers are charged 6 cents per lineal foot for city inspection. Engineering provided for through department appropriation. Very complete rules and specifications are provided, and whole drain is laid to the satisfaction and under the direction of the City Engineer.

FALL RIVER	City locates branch, gives grade at which sewer is to be laid, and attempts to see that work is properly done.
HAVERHILL	Grades furnished by Engineering Department, if desired, or in cases of long runs and slight fall. All connections inspected by "Inspector of Plumbing" before being covered.
LAWRENCE	Street Department sends a man to make first pipe connection with sewer. This is all city does in the line of inspection.
LYNN	Any engineering, and proper inspection by Plumbing Inspector.
MALDEN	City furnishes line and grade: the specifications for work are detailed and complete, and whole work is inspected by the city.
NORTH ADAMS	Plumbers are licensed and their work inspected under direction of the Engineering Department. They lay the drain from street line to house. City reserves the right of supervision all the way to house, by virtue of its plumbing ordinance.
SOMERVILLE	City furnishes free all engineering and inspects whole connection.
TAUNTON	Pipe must be inspected for whole length before covering. No engineering done.
WALTHAM	Give people to understand that city does not assume responsibility for licensed sewer layer's work. If they want guaranteed work they must employ city force. From L. S. L. we require only work which will not be detrimental to sewer mains.
WORCESTER	Assistant from City Engineer's office has this work in charge.

RHODE ISLAND.

NEWPORT	Only nominal.
PAWTUCKET	City locates Y and inspects whole connection. Work done under complete rules for sewer and parts of the plumbing. Drain layer returns permit with statement of number of fixtures draining into connection, and certificate that work was done according to rules. Inspector countersigns this and gives sketch of location for record in office.
PROVIDENCE	An inspector, who gives the point, makes a diagram of the work and looks after in a general way the character of the work being done.
WOONSOCKET	All engineering and inspection.

OTHER STATES.

ALBANY	All plumbing work inspected by inspector of Board of Health.
BUFFALO	City plans and supervises construction, or plans are approved by Engineers' Department.
CINCINNATI	City furnishes engineering and inspection.
CHICAGO	Work done under Drain Inspector.
CLEVELAND	Under city inspection.
COLUMBUS	Sewer Tap Inspector sees connection made and tries to secure effective tamping of back filling.
MINNEAPOLIS	Inspector lays out the work, inspects all material used, sees to the proper grade being used, pipes carefully cemented and cleaned out and watches refilling that it may be carefully puddled and tamped.
NEWARK	Sewer Tap Inspector sees that connection with main sewer is made properly, and an officer from Board of Health, from that point to the building.
NEW YORK CITY	Plumber notifies department when ready to make connection and an inspector is sent to see it properly made.
PHILADELPHIA	Registered plumbers do the work, city inspects. Bureau of Health passes on the drainage plans.
ROCHESTER	Work must be inspected by inspector from Street and Sewer Department. A portion of cost of inspection is charged to property owner. Cost of engineering is not charged.
ST. LOUIS	Work inspected by inspector from Sewer Department. Drain layer charged $1 for each inspection.
ST. PAUL	Done by licensed contractors under city inspection.
WASHINGTON	Work is inspected by inspectors of the Plumbing Division.

12. What qualifications are required of inspectors on sewer work and what prices per day are paid?

CONNECTICUT.

BRIDGEPORT	No qualifications. Wages $3 to $4 of eight hours when employed. Present Inspector well qualified.
BRISTOL	Wages $3.
DANBURY	No particular qualifications are required. The City Engineer has the selection of an inspector. Prices, $3 to $3.50.
EAST HARTFORD	Knowledge of sewer work and some experience in engineering.
FARMINGTON	Wages, $2.50.
GREENWICH	Inspectors are appointed by engineer in charge.

HARTFORD	Must be union brick layers. Appointed by Ways and Means Committee of Common Council, from list of two or more, recommended by City Engineer. Wages, 50 cents per hour.
NEW BRITAIN	Inspector is Clerk of Sewer Board.
NEW HAVEN	First class brick mason. Must pass civil service examination. $4.50 for nine hours.
NEW LONDON	Thorough knowledge of plumbing and drain laying. $3.00.
NORWALK	The present Inspector is well posted as to material to be used in construction, and in the manner of performing the work, having been in the work about fifteen years. I think that he gets $3.00 when actually ally at work.
NORWICH	Street Superintendent acts as Sewer Inspector.
RIDGEFIELD	Wages, $3.
SIMSBURY	Wages, $4.
SOUTH NORWALK	Inspector is a competent person and thoroughly understands business. Paid by the year to care for streets and sewers—amounts to about $3.
STAMFORD	Inspector is paid $2.50, and is supposed to be qualified for the position.
WALLINGFORD	A pull with the powers that be. Wages, $2.50.
WATERBURY	$2.50 is standard for ten hours. Largely done by young men who have had more or less training with engineer party. Many cases only receive apprentice pay.

MASSACHUSETTS.

BOSTON	[illegible] pipe work, [illegible] brick work, eight hours. For [illegible] please address Civil Service Commissioners, State of Massachusetts.
BROCKTON	An experienced engineer is in charge of the work, for general oversight we have found students from the technical schools or young men brought up in the engineering office to give good satisfaction at from [illegible] to $3.
[illegible]	We employed masons to some extent, but more largely and more satisfactorily the younger assistants in the office to whom we pay rather larger wages than when employed as instrument men—ranging from $15 to $24 per week.
[illegible]	Inspector is the Superintendent of Sewers.
[illegible]	Examination necessary under civil service rules. Salary ranges from [illegible] to $5.00. Pipe and masonry construction.
[illegible]	No inspector employed as such. A member of the engineering force attends to that, together with other work.

Fitchburg	Have no inspector; city work.
Haverhill	None employed.
Holyoke	On brick sewers an experienced brick mason is present all the time to see that work is properly done. Wages, $5.00. General supervision by City Engineer.
Hyde Park	Inspectors work under a printed set of instructions, which cover the work in very great detail. They are required to keep sketches of details of work, continuous profiles, list of quantities of all materials used, number of men employed and wages, location of all slants set and water and gas pipes encountered, etc., beside being personally responsible for the excellence of all details of the work. Wages usually $3, varying from $2.50 to $4.00.
Lawrence	Civil service examination.
Lynn	Civil service examination. Wages, $3; sometimes $4 on brick work.
Malden	A knowledge of materials and construction satisfactory to the City Engineer. Wages, $2.50 to $2.75.
Newton	Civil service examination. Wages, $2 to $4.
North Adams	Civil service examination. Wages, $2 to $4.
Quincy	Civil service examination. Wages, $2.50 to $3.50.
Somerville	Inspectors furnished from engineering department. Wages, $2.50 to $3.50.
Springfield	Under civil service regulations and must pass prescribed examinations. Wages, $4.00.
Taunton	Assistants from engineering office employed as inspectors as far as possible. Wages, $2 to $2.75.
Waltham	Civil service examination. Wages, $2 to $3.
Worcester	Assistants from City Engineer's office do engineering and necessary inspecting.

RHODE ISLAND.

Pawtucket	Inspector of private drains receives $22 per week. New work done by city. Foremen receive $27 per week.
Woonsocket	Inspectors are from City Engineer's office, detailed as required. Wages, $2 to $3.

OTHER STATES.

Albany	Civil service examination. Wages, $4.
Baltimore	Men must be practical sewer builders and understand nature of the work.
Buffalo	Civil service examination. $3 for eight hours work.
Cincinnati	Knowledge of the work—usually brick layers are employed. Wages, $3.50.
Chicago	On main sewers they are practical masons. Wages, $4.

CLEVELAND	Shall have had one year's experience on similar work. Wages, $3.50.
COLUMBUS	Young engineers, or experienced practical men. Try to pick best from those available.
DETROIT	Required to have a knowledge of that class of construction. Chief inspectors (2) $3.00. Others $2.50.
NEWARK	No special qualifications required; the political custom is still in vogue, and a new man appointed for almost every new work. Wages, $3.50.
NEW YORK CITY	They are supposed to have a knowledge of pipe and brick laying and be able to carry grade from the marks left by the engineer. Pay, $4.
PHILADELPHIA	Inspector must be a plumber. $100 per month.
ST. LOUIS	Must be skilled sewer brick- or drain-layers of at least ten years experience. Salary, $85 per month.
ST. PAUL	Must be experienced man. Wages, $2.50.
SAN FRANCISCO	Civil service examination. Wages, $4.
WASHINGTON	Actual experience in sewer construction. $4.00.

13. To whom, or to what account are these inspectors' wages charged?

CONNECTICUT.

BRIDGEPORT	Cost of construction.
BRISTOL	To cost account during construction, since then to maintenance.
DANBURY	Cost of construction.
EAST HARTFORD	Engineer's account.
FARMINGTON	Sewer Department.
GREENWICH	Sewer account.
HARTFORD	Cost of construction.
MERIDEN	Cost of construction.
MIDDLETOWN	All expense of inspection is borne by city at large.
NAUGATUCK	Not answered.
NEW BRITAIN	Sewer Department.
NEW HAVEN	To cost of the sewer he inspects.
NEW LONDON	To city; under maintenance—plumbing inspection.
NORWALK	To sewer account—appropriation for maintenance.
NORWICH	To city.
RIDGEFIELD	Cost of construction.
SIMSBURY	Cost of construction.
SOUTH NORWALK	Highway Department.
STAMFORD	Health and Sewerage Department.
WALLINGFORD	Sewer account.
WATERBURY	To sewers—"New work" for new sewers, "plumbing inspection" for connections.

MASSACHUSETTS.

Boston	To cost of the sewer.
Brockton	Construction account.
Brookline	To sewer expenditures.
Cambridge	Maintenance of sewers.
Everett	To Sewer Department—maintenance and construction fund.
Fall River	Engineering Department.
Holyoke	To account of sewers and drains.
Hyde Park	Town pays wages—charged to sewer construction.
Lynn	To cost of sewer.
Malden	Sewerage maintenance.
Newton	Sewer account.
Quincy	Construction.
Somerville	Engineering account and sewers—maintenance account.
Springfield	To account of sewer for which inspection is performed.
Taunton	City—sewer construction.
Waltham	Sewer construction.

RHODE ISLAND.

Pawtucket	Charged to each job.
Woonsocket	Charged to sewers they inspect.

OTHER STATES.

Albany	Added to cost of sewer.
Baltimore	City.
Buffalo	General fund.
Cincinnati	To property where assessed.
Chicago	Annual appropriation from general taxes.
Cleveland	To fund under which work is done.
Columbus	To work he inspects.
Detroit	Spread upon assessment roll.
Newark	Cost of improvement.
New York City	To cost of work he inspects.
Philadelphia	Direct appropriation.
St. Louis	Maintenance of Sewer Department.
San Francisco	Paid by contractor through Board of Public Works, and charged with other incidental expenses to property owners.
Washington	Against the appropriation for sewer construction.

14. Does your city bear the whole or any part of the cost of sewer construction?

CONNECTICUT.

Bridgeport	One quarter, except in exceptional cases.
Bristol	Borough one-half, assess one-half.
Danbury	One-third.
East Hartford	One-fourth.
Farmington	Whole cost.
Greenwich	Main sewers paid for by borough. Lateral sewers assessed on abutting owners.
Hartford	City pays entire expense of intercepting sewers, which drain large districts or sections of the city. In rebuilding some sewer systems which have been in use fifty or more years, and which have become inadequate to properly drain the districts required of them as well as partially worn out, the city at large has assumed one-half of the expense. Aside from the above and a few special cases, the city pays no part of new sewer construction, except engineering services.
Meriden	City pays cost of engineering and superintendence, maintenance and care of system and disposal farm; also pays for street intersections and exemptions for corner lots.
Middletown	One-third.
Naugatuck	So far have laid sewers only toward river at expense of property owners.
New Britain	City bears what cost is left after assessment is laid.
New Haven	Property owners pay $1.75 per front foot, with exemptions for corners, shallow lots, etc. City pays balance of cost, by an issue of sewer bonds. Impossible to tell exact proportion borne by city, but think one-half.
New London	Maintenance.
Norfolk	Municipality or Fire District bears the entire cost, except service connections.
Norwalk	The whole.
Norwich	A part.
Ridgefield	The whole.
Rockville	The whole.
South Norwalk	One-third.
Stamford	Half or more.
Wallingford	A part.
Waterbury	City pays whole cost from annual appropriation, but levies an assessment after completion.

MASSACHUSETTS.

Boston	All expense over $4.00 per lineal foot of sewer.
Brockton	It is the intention, under the present assessment system adopted in 1894, that one-fourth the cost of entire sewerage system be assessed on abutting property when sewer is built, one-half be raised by annual rentals and remainder by general tax.
Brookline	Disregarding interest, it was expected when the assessment rate was adopted that the property would pay about two-thirds and town one-third.
Cambridge	City supposed to pay one-fourth of average cost of sewers.
Everett	It was intended that assessment system would make a return of 50% of cost. 39½% was returned last year.
Fall River	The whole.
Fitchburg	City pays for all manholes and catch basins, and one-fourth of all main sewers.
Haverhill	By revised ordinances of 1896 amount collected by fixed rate of assessment is estimated to be 35% of cost of entire system. For the years since 1896, however, it has averaged over 50%, as no main sewers have been built.
Holyoke	City builds sewers and assesses a portion of the cost against abuttors.
Hyde Park	Town issues bonds, a certain portion of which are retired each year by tax levy. Abutting estates are assessed one-half average cost of sewers, and money thus obtained is available for further construction.
Lawrence	Part.
Lowell	About half the cost of small sewers.
Lynn	Part.
Malden	About one-third.
New Bedford	Practice not always uniform. Usually a trunk sewer, that is, a sewer receiving a number of others, is paid for entirely out of general taxation, whereas lateral sewers have one-half their cost assessed on abutting property.
Newton	One-half the estimated cost.
North Adams	One-half.
Somerville	Abutting property owners generally pay complete cost of sewer construction on small lateral sewers. Law allows assessment of total cost, but if it amounts to over $2 per foot, city generally assumes the excess.
Springfield	About three-fourths of entire cost of system. Remainder covered by entrance fees.
Taunton	Abuttors are assessed not less than one-third, nor more than three-fourths of expense. See No. 17.

WALTHAM	About one-half.
WORCESTER	A part, usually one-fourth. It may vary somewhat, as Committee on Sewer Assessments may determine.

RHODE ISLAND.

NEWPORT	The whole.
PAWTUCKET	Over two-thirds.
PROVIDENCE	In original design it was intended that city should pay two-fifths.
WOONSOCKET	About one-fourth.

OTHER STATES.

ALBANY	None.
BALTIMORE	Whole cost.
BUFFALO	No part as a rule—some exceptions.
CINCINNATI	All in excess of $2 per abutting foot.
CHICAGO	None—except intercepting sewers, which are charged to water fund.
CLEVELAND	Part—frontage taxed $2 per foot. Balance paid from sewer district funds, which are raised by general tax.
COLUMBUS	Large trunk, storm water, or combined sewers paid for by city. Entrance fee charged.
DETROIT	Whole for trunk or main sewers and for lateral arms within street limits.
MINNEAPOLIS	Part.
NEWARK	There is no regular percentage of cost assumed by city. As a rule, where branch sewers are laid, whole cost is assessed upon property owners. Statute laws require that amount assessed on property shall be the peculiar benefits derived from the improvement.
NEW YORK CITY	Cost of new sewers and of alterations and improvements is assessed. Repairs are paid by city.
PHILADELPHIA	All cost in excess of assessment against abutting property.
ROCHESTER	No part.
ST. LOUIS	Whole cost for the main drainage [illegible]. Laterals charged to property owners.
ST. PAUL	City pays for main sewers—practically for all sewers costing more than [illegible] per front foot. Money formerly raised by bond issue, now by direct taxation.
SAN FRANCISCO	Paid whole cost of some main sewers. [illegible] toward cost of others. Under proposed charter city will construct a system of sewers.
WASHINGTON	City bears cost of main sewer construction. Sewers below [illegible] diameter are constructed at [illegible] of city and abutting property.

15. How is the amount assessed against abutting property proportioned and levied?

CONNECTICUT.

BRIDGEPORT	So much per front foot.
BRISTOL	Not answered.
DANBURY	$1.25 per front foot; the small sewers making up in returns from assessments the extra cost for large ones.
EAST HARTFORD	Assessment system not yet ready for publication.
FARMINGTON	No assessments. Amount raised by tax on grand list.
GREENWICH	Assessments on basis of front feet.
HARTFORD	The whole cost of new sewers, including inspection, is levied on property benefited. On "local sewers," including sizes up to perhaps 15 inches in diameter, which drain short blocks in isolated districts, the whole cost is paid by abutting property, one-half on each side, at the same rate per front foot. Where "trunk sewers" draining large districts are first built in the lower sections of the district, a fair assessment per front foot (from $1.00 to $1.50) is levied on property fronting on the street containing the large sewer, and the excess cost spread over the remainder of the district, either by a small rate per front foot, if property is developed and streets laid out, or by an area assessment if land is undeveloped. In fixing these rates, which in some cases are arbitrary amounts determined by past experience, the Board of Street Commissioners intend to so proportion the expense on the section not having the sewer, built with the trunk sewer, that when the smaller tributary sewers are built the assessment per front foot for said tributaries, plus the assessment for outlet purposes levied with the trunk sewer, will be about the same amount over the entire district.
MERIDEN	Have a Board of Compensation who assess the benefits, which are proportioned to the value (as determined by said Board) that the property receives from said construction. On residential streets it averages about $1.00 per front foot, each side; on business streets somewhat more. Levied by Court of Common Council, and collected same as general tax.
MIDDLETOWN	Property owners on each side of street each bear one-third of total cost of sewer, and city the other third.
NAUGATUCK	Sewers already built have been assessed according to frontage on street.
NEW BRITAIN	According to front foot, and contour of land, no land below three feet above water being assessable.

New Haven .... A uniform assessment is laid of $1.75 per front foot, but abatements are allowed for sharp corners, shallow lots, city property (as schools, parks, etc.), and where there is absolutely no benefit to be derived. On corner lots 75 feet is exempt on one street.

New London .... Sewers are paid for by an issue of city sewer bonds. For all laterals, and for interceptors when in a street, an assessment is collected from abutting property, which was so planned that the district benefited by sewer should eventually pay face value of bond issue, city at large paying interest and maintenance charges. The uniform rate is fifty cents per front foot, plus seven mills for each square foot within 100 feet of street, 100 feet exempt as corners, and with such other modifications as Board of Sewer Commissioners deem just, the plan being to raise six-tenths by area assessment and four-tenths by frontage.

Norwich .... Thirty cents on each front foot and twelve mills on each square foot within one hundred feet of the street, is usually assessed on each abuttor. City at large pays balance of cost.

South Norwalk ... One-third of entire cost assessed on property actually benefited on each side of street.

Stamford .... At certain rate per front foot with additional rate for improvements.

Wallingford .. All abutting property is assessed seventy-five cents per front foot. City pays balance, if any.

Waterbury . $1.50 per front foot on all property, each side. ($3.00 per lineal foot, taking both sides.) Exemptions on corners lots, church property, land under water, etc.

MASSACHUSETTS.

Boston . . Cost of sewer not exceeding $4 per foot assessed on abutting property in proportion to frontage of estate; but cannot assess in excess of benefit conferred to each estate, to be determined by Street Commissioners.

Brockton When sewer is built a first assessment is charged, being 5 cents per front—100 feet exempt on corners—and three mills per square foot for land which can be drained, lying within 125 feet of street. After connection is made annual rental is charged, based on water consumption. See No. 17.

Brookline It is based on an estimated average cost of the sewers and amounts to 75 cents per foot of frontage and three-fourths cents per square foot for all land within 100 feet of street or way in which sewer is constructed.

Cambridge	Amount assessed is fixed by city ordinance at 28 cents per front foot and 5.2 mills per square foot for all abutting property.
Everett	Fifty cents per front foot is assessed on all abutting property.
Fitchburg	In some sections of the city by area, and in others by frontage.
Haverhill	At a uniform rate of 20 cents per foot frontage, and 0.4 mills per square foot of area within 150 feet of street.
Holyoke	Eight cents per front foot, and 5 mills per square foot of area within 120 feet of street, is regularly assessed. For corner lots only one front is assessed. Land too low to enter, or which for other reasons cannot use sewer, is not assessed until difficulty is obviated by abuttors and sewer entered by them.
Hyde Park	A fixed amount is assessed against abutting property, namely, 47 cents per front foot, and 5 mills per square foot for all land within 70 feet of the street, which amount was intended to pay one-half of the total cost of the sewer system.
Lawrence	6.5 mills per square foot for land within 100 feet of street is assessed as property. Entrance fee of $10 is charged for connections from buildings more than 100 feet from street. These entrance fees are deducted from a regular assessment where levied.
Lowell	Not answered. According to city ordinances one-half of the expense of constructing sewers, also whole cost of manholes and catch basins, is paid by city. Also "Board of Aldermen shall determine amount of each lot of land benefited by . . . sewer, and assessment shall be . . . apportioned among the owners . . . according to value of land benefited, independently of buildings and improvements."
Lynn	Sixty-five cents per front foot is regularly assessed. Corner lots exempt one-half the sum of two sides.
Malden	$1.00 per front foot is assessed, or a system of rentals based on annual water bills is charged. See No. 17.
New Bedford	Amount assessed is based upon the value of property for an assumed depth back from street line. Where depth of block permits we use 100 feet for the arbitrary depth of assessment area. Sometimes the depth of properties to be assessed may be 75, 80 or 90 feet, in which case the assessment line is made to conform to the average depth of these properties.
Newton	Assessment is at a fixed rate of 15 cents per front foot, and 5.5 mills per square foot area within 180 feet if drainable. These amounts were estimated to pay an average of $2.085 per foot, or one-half the cost of the entire system.

NORTH ADAMS ...... An entrance fee is charged—$15 for a single dwelling, $10 per tenement for blocks, with special rates for hotels, factories, etc.

QUINCY .... Twelve cents per foot frontage, and 6 mills per square foot of area within 100 feet of street. City property not assessed.

SOMERVILLE .... Proportioned according to frontage and area within 100 feet of street line, half on each. Rate varies with cost of each sewer built.

SPRINGFIELD .... No assessments are made, but an entrance fee is charged when connection is made with sewer. See No. 17.

TAUNTON .... An average price of 50 cents per foot is charged on entrance, as a temporary assessment. See No. 17.

WALTHAM .... Various ways. Original system was assessed on valuation and area. Last six years' extensions have been assessed on area and frontage.

RHODE ISLAND.

PAWTUCKET .... Twenty-five cents per front foot and 5 mills per square foot for all land within 100 feet of street. On corners same area is never assessed twice.

PROVIDENCE .... Sixty cents per front foot, and 1 cent per square foot of area within 150 feet of street, or half way to next street. Corner lots pay frontage on both streets, but area tax on only one.

WOONSOCKET .... Fifty cents per front foot and 7.5 mills per square foot for land within 150 feet of street, or half way to next street, is assessed on abutting property. Area of corner lots assessed once only.

OTHER STATES.

ALBANY First, frontage, second, valuation, third, area, fourth, property, whether improved or unimproved.

BUFFALO Per front foot and surface drainage. Determined by the assessors.

CHICAGO By special assessment in proportion to benefits.

CLEVELAND Uniform assessment of $2 per front foot, except on corner lots.

COLUMBUS On large trunk, storm water, or combined sewers, which are paid for by city, entrance fee is charged, 50 cents to $1 per front foot. Law allows three methods of assessment: by taxable valuation, by front foot, or by benefits received. Last two commonly used.

DENVER On main sewers, from an annual allowance by city council. For laterals, assessment is by square foot of area.

Minneapolis	Abutting property is assessed an amount per front foot, equal to cost per foot of sewers if not larger than 24 inches circular. Any sewer larger than 24 inches circular is assessed at the average rate of a 24-inch sewer.
Newark	As most blocks are 200 feet in width, the limit of assessment extends to middle of block on either side of street. Only in rare cases, where depth of lot is less than 50 feet, is area also considered, otherwise only frontage.
New York City	According to benefit.
Philadelphia	Assessment made by District Surveyors at rate of $1.50 per foot front of property abutting sewer, with legal deductions for corner lots.
Rochester	Amount assessed against abutting property owner is proportioned by Board of Assessors, in proportion as it may deem each separate piece of property benefited. The usual method is to divide cost into two parts, one part being for outlet purposes, and spread this over entire territory, taking into account area and frontage. The remaining portion is assessed upon the property directly benefited; that is, the sewer would afford opportunity for connecting abutting property directly with it.
St. Louis	Whole cost of all laterals in a district defined by ordinance is charged as special tax, in the proportion that area of each lot bears to area of whole district, exclusive of public highways.
St. Paul	Assessment made according to benefits derived. In practice this means a front foot assessment.
San Francisco	See No. 17.
Washington	In proportion to length of sewer abutting on property.

16. What conditions are made regarding the time allowed for the payment of sewer assessments, and what discount allowed for prompt payment?

CONNECTICUT.

Bridgeport	Thirty days from time of assessment for payment, then lien is filed against delinquent, drawing interest.
Bristol	Not answered.
Danbury	Time limit is set by Court of Common Council, usually sixty days from date of final action on the assessment. No discount for prompt payment. If not paid within said time limit, lien is filed.

GREENWICH .... Lien on property if not paid in sixty days. No rebate for prompt payment.

HARTFORD .... Lien on property if not paid within three months. 4% discount for prompt payment.

MERIDEN .... Four months time from date of assessment in which to pay. No discount.

MIDDLETOWN .... Lien filed on property if not paid in specified time. No discount.

NAUGATUCK .... Time named in assessment; usually thirty days or more.

NEW HAVEN .... Sixty days after final notice to pay, liens are filed. The bills have seldom been sent in until one year after sewer was built. No discount.

NEW LONDON .... Usually sixty days allowed, after which interest is charged at 6%. In special cases can pay on installment plan.

NORFOLK .... No discount. Tax made payable at stated times and if not paid becomes a lien on property with interest same as town tax.

NORWICH .... Time in each case fixed by resolution of Common Council. No deduction. Interest charged from date fixed.

SOUTH NORWALK . Sixty days, no discount.

STAMFORD .... Thirty days, no discount.

WATERBURY ..... No discount. Lien filed after ninety days. Interest charged after one year. (7)

MASSACHUSETTS.

BOSTON .... Payment due on presentation of bill, runs without interest thirty days, then draws [illegible]% interest. If not paid within one year from date of bill, [illegible]% of principal plus [illegible] interest on principal is added each year to real estate tax and cannot be separated from it. Last [illegible] of principal not collected. For instance: a bill of [illegible] would be [illegible] + $4.50 = $1[illegible].50 each year for ten years.

BROCKTON .... No discount. Must be paid in thirty days or pay 6% interest. If not paid in two years property is sold. Owners may by petition obtain right to pay in ten annual payments with interest.

BROOKLINE .... Sixty days are given property owner, either to pay, or ask for an apportionment. If apportioned, one-third of the amount plus interest at [illegible]% is added to tax bill each year. Interest at same rate charged for delay in paying where not apportioned.

[illegible] .... No discount. Assessments collected same as taxes.

[illegible] .... No discount. Collections supposed to be made three months from date of bill. Interest at 6% per annum is charged after thirty days.

Fitchburg	No discount. Interest at 6% is charged after three months.
Haverhill	No discount. Assessments due on presentation of bill, and property sold if unpaid after two years. Assessments can be divided into three annual payments, with interest, on request.
Holyoke	A certain time is allowed after completion of sewer for payment, and after that time interest is charged.
Hyde Park	No discounts. Assessments payable within three months from date of bill. If not paid, interest is charged at 6%. Assessment may be apportioned, upon written request of property owner, into annual payments not exceeding five, with interest, and when so apportioned are added to regular tax bill.
Lawrence	No discount. If unpaid three months from date of bill, lien is filed.
Lowell	No discount. Interest at 6% charged after thirty days.
Malden	No discount. If not paid within time specified in bill, interest is charged; if unpaid after two years, property sold. Total assessment may be apportioned into not exceeding ten annual payments, with interest, if so requested, in which case a portion is added each year to tax bill. Whole amount due may, however, be paid at any time. This is in accordance with a general state law. (Chap. 380, Acts of 1893.)
New Bedford	No discount, and no fixed conditions as to time allowed for payment of assessments. Under State laws they become a lien same as regular taxes and property can be sold for same, but it is only rarely that Treasurer does this. As a rule, sewer taxes are very promptly paid, as sewers are seldom laid, except upon petition by owners of abutting property. Now and then Board of Public Works rebates an assessment, where the individual may have already provided a private connection with an existing sewer at considerable expense to himself.
Newton	Assessment payable within thirty days of date of bill, draws interest at 5% for two years, after which property may be sold. Assessments may be apportioned under general State laws into not over ten annual payments.
North Adams	Entrance fee must be deposited at time of application.
Quincy	Interest begins three months after assessment. Assessment must be paid within three years, except that it may be apportioned, according to State law, into any number of equal annual payments, not exceeding ten, which are added to tax bill.
Somerville	No discount. Interest charged if assessment is not paid in two months. Property sold after lapse of two years.

GREENWICH	Lien on property if not paid in sixty for prompt payment.
HARTFORD	Lien on property if not paid withi 4% discount for prompt payment.
MERIDEN	Four months time from date of asse to pay. No discount.
MIDDLETOWN	Lien filed on property if not paid in sp discount.
NAUGATUCK	Time named in assessment; usually thi
NEW HAVEN	Sixty days after final notice to pay, lie bills have seldom been sent in unti sewer was built. No discount.
NEW LONDON	Usually sixty days allowed, after w charged at 6%. In special cases ca ment plan.
NORFOLK	No discount. Tax made payable at st not paid becomes a lien on prope same as town tax.
NORWICH	Time in each case fixed by resolution o cil. No deduction. Interest charged
SOUTH NORWALK	Sixty days, no discount.
STAMFORD	Thirty days, no discount.
WATERBURY	No discount. Lien filed after ninet charged after one year. (?)

MASSACHUSETTS.

BOSTON	Payment due on presentation of bi terest thirty days, then draws 4 paid within one year from date and 4½% interest on principal real estate tax, and cannot be s 10% of principal not collecte of $100 would be $9.00 + $4.5 ten years.
BROCKTON	No discount. Must be paid i interest. If not paid in tw Owners may, by petition, annual payments with inter
BROOKLINE	Sixty days are given prope ask for an apportionmen of the amo [illegible] plus inter for each ye [illegible]. Interest in paying. where not a
CAMBRIDGE	No discount [illegible]
EVERETT	No discou [illegible]

SPRINGFIELD .... Entrance fees are payable in advance, before any work is done by Superintendent of Sewers.

TAUNTON .... No discount. By application to assessors of taxes, assessment may be apportioned into not over ten annual payments, which are added to general tax bill. Assessments must be paid or application for apportionment made before permit for connection is issued.

WALTHAM .... No discounts, except that prompt payers escape interest charges. Assessments can be apportioned in ten annual payments.

WORCESTER .... Assessments due thirty days after levied. If abuttors wish they may pay in three annual installments with interest.

RHODE ISLAND.

PAWTUCKET .... Payable sixty days after confirmation of assessment by Board of Aldermen. On petition, payment may be made in three parts, one within sixty days and two annually, with interest. Treasurer has authority to levy on property and collect after sixty days if no petition for division has been received.

PROVIDENCE .... Can be paid all at once with 6% discount, or in three yearly installments, paying 6% on amounts held over.

WOONSOCKET .... Payable in one year, or may be apportioned into five annual payments with interest at 5%. In case of default in payment of assessment, or any portion thereof, the whole unpaid balance becomes due, and thereafter bears interest at 6%.

OTHER STATES.

ALBANY .... No discount. If not paid within fifteen days interest is added.

BUFFALO .... Under $5,000 paid as soon as work begins. Above $5,000 in five annual installments with 6% interest.

CHICAGO .... Assessments put into collection January 1st, after completion of work. May be levied in one, five, or ten installments at 5% interest.

CLEVELAND .... No discount—three to five years.

COLUMBUS .... No discount; penalty of 10% if not paid.

DETROIT .... Assessments are made in four equal annual payments. The first payable thirty days after acceptance of work and publication of same. 7% is added after thirty days, and if not paid when due parties penalized 5% additional.

MINNEAPOLIS .... The taxes are payable in five equal annual installments, 5% interest added, or the whole assessment may be paid at once and the 5% interest thereby saved.

Newark	After assessment is confirmed by the Court, bills are sent out, giving forty days for payment without interest charge. If not paid within this time, but within six months after date of bill, interest is charged at 6%; after this time at 8%. If not paid within three years property can be sold at auction to recover lien.
Philadelphia	Contractors are paid in part by assessment bills. Thirty days after presentation allowed. Lien filed within six months. No discount.
Rochester	Time allowed for payment for sewer assessments varies from three to ten payments. In the case of three- or five-payment rolls, interest for entire time is added in to total cost and a rebate made of unearned interest when payments are made. In the case of ten-payment assessments they are made net, and interest is added to the deferred payments. Interest on the ten payments is 5%.
St. Louis	Payable in not less than three nor more than seven annual installments. Number of installments must be prescribed in ordinance authorizing the work. This number is gauged by amount and cost of work in hand.
St. Paul	After assessment is completed by Board of Public Works, the rolls are turned over to City Treasurer, who notifies property holders to pay within thirty days. If not paid he applies to the Court for judgment. Judgments can be paid inside of five years in any amounts with accrued interest at 12%. Property sold for judgment against it, but can be redeemed inside five years upon payment of amount of judgment.
San Francisco	When an assessment has been made, the contractor collects amounts due from property owners on the basis of assessment made by Board of Public Works.
Washington	One-third within sixty days after service of notice of assessment, one-third within one year and one-third within two years; 8% interest on all after sixty days from service of notice. No discount.

17. Please explain your practice in making sewer assessments?

CONNECTICUT.

Bridgeport	Per front foot. On small sewers three-fourths of entire cost. On large sewers (trunks), proportional amounts set off for lateral streets, whether sewer is

constructed in such streets or not. If not constructed, said amount rests until the lateral is constructed, then is included under item of "outlet" in the expense.

DANBURY .... City Engineer reports to Common Council the frontage on said sewer. Council then lays an assessment of $1.25 for each front foot on each side of street, giving notice of so doing that all interested parties may be heard if they desire. If sewer is built around a corner, 75 feet is exempt. Street intersections, etc., are paid for by the city as a whole.

GREENWICH .... Assessments on basis of front feet.

HARTFORD .... A map is first made showing location and ownership of all property which will be drained or benefited directly or in the future by the proposed sewer or system of sewers. Sewer is then laid out, and an estimate of cost made by the City Engineer. Map and estimate are then submitted to the Board of Street Commissioners, who fix the form of assessment, usually in line with the information given under questions 14 and 15. On corner lots assessment is levied on the frontage, and 150 feet exempted on the side. Notice of the layout and assessment is then given, and parties interested have an opportunity to remonstrate against layout or appeal from assessment. The action of the Board of Street Commissioners is then ratified by the Court of Common Council, and sewer constructed. The first assessment levied is called a preliminary assessment and is a maximum. If sewer actually costs more than City Engineer's estimate, the city at large must pay the difference. If cost of construction is less than estimate, the final assessment is proportionately reduced. Under this form of assessment the City Engineer, being an employee of the city, usually estimates the cost about 25% above the actual expense.

[illegible] .... So far have made only one small assessment on basis of frontage.

NEW BRITAIN .... Assessments not to exceed $1.75 per front foot. Everything left to Board of Street Commissioners.

NEW HAVEN .... Assessment maps are made with owners' names within [illegible] as shown. With names are given references to [illegible] Town Clerk's office, Probate office, [illegible] record of importance. Fronts are adjusted to [illegible] dimensions and actual measurements, and the amount due, according to adjustment [illegible] each property. These maps are turned over to the Bureau of Compensation, who, after several hearings and personal investigation, if thought necessary, decide on the matters. Then approved by Common Council and the names and amounts turned over to the Tax Collector for collection.

ORFOLK .... District issues bonds for construction. Tax is laid sufficient to meet interest on bonds, cost of running expenses, and to create a sinking fund for the liquidation of bonds at maturity. Tax this year is 3½ mills. We avoid all assessments of benefits or on frontage.

ORWALK .... No assessments. The annual appropriation is usually large enough so that after the sewers in operation are cared for there is money enough left to sewer one or two streets on the outskirts, which are generally short, with pipes not exceeding 12 inches in diameter. Excepting one small district which is very low, and the sparsely settled streets on the outskirts of the city, we are well sewered.

ORWICH .... Assessment made by Common Council through a committee and collected by the City Treasurer. The rate is not fixed by ordinance or charter, but usual custom is 30 cents per front foot and 12 mills per square foot within 100 feet.

TAMFORD .... A committee to make assessments is appointed by the Mayor from the members of the Board of Common Council. They make assessments at the rate of ** cents per front foot, according to cost of sewer, with a small additional amount for improvements on property.

MASSACHUSETTS.

ROCKTON .... The intention is that one-fourth of total cost of system shall be paid by assessment on abutting property, one-half by a system of annual rentals and remainder by city. The rates which would produce this result were calculated from estimate of cost of sewers which would probably be built in next few years, and fixed by ordinance as follows: when sewer is built, an assessment proportioned six-tenths on area and four-tenths on frontage is levied on all property within 125 feet of street which can be drained by sewer—if too low, assessment is held until land is filled—rate is now 15 cents per front foot and 3 mills per square foot. When sewer is used, an annual rental is charged, based on water rates, thus: for unmetered service, $8.40; for metered service, $0.28 per 1,000 cubic feet of water used; with discount: for factories 70%, and for all other buildings having sill-cocks 20%. Said rentals are collected quarterly, in same manner as tax bills.

BROOKLINE	Assessments being based on prices given under No. 15, a blank is filled out with names of all abutting property owners, their frontage, amount at 75 cents per foot, their area within 100 feet of street, amount at ¼ cent per square foot and total assessment; under this is written a certificate for signatures of selectmen laying the assessment, and fixing date when it is due.
CAMBRIDGE	In determining the rates of assessment, the total probable cost of a system of sewers was estimated. It was planned that the city should pay one-fourth of this cost and the benefited property three-fourths. By figuring, this was found to represent about two dollars per front foot for all abutting property. This amount was to be levied, six-tenths by frontage and four-tenths according to the area within 100 feet of the street, and preliminary figures showed that this would amount to about 28 cents per front foot and 5.2 mills per square foot. These amounts were fixed by ordinance and are now used in all cases. The City Engineer submits to Board of Aldermen plans of estates to be assessed, showing names, frontage and areas. The legal amounts are then assessed and entered on said plans.
EVERETT	Sewer plans are prepared, on scale of 50′ to 1″, showing houses, sewers, and dimensions of benefited property. The order passed by city government to lay a sewer places a lien on property upon adoption of the order, notwithstanding several months may elapse before commencement of work on sewer.
FALL RIVER	We have none. Have made several attempts, but as it seemed impossible to get at a system which would not work injustice in certain cases, the whole matter has been dropped. We are waiting for the perfect thing of which so much is said and so little is seen.
FITCHBURG	We divide three-fourths of cost of sewer, exclusive of manholes and catch basins, upon the abuttors, in proportion to the area owned by each within 100 feet of the street line; in some sections of the city it is divided in proportion to the feet of frontage owned by each.
HAVERHILL	The cost of a sewer, on completion, is certified by Superintendent of Streets to City Engineer, who certifies same to Board of Aldermen, together with a certificate of names of abuttors, with frontage on sewers and area of land liable to assessment. Assessments are made by Board of Aldermen in accordance with certificate of Engineer and committed to "Treasurer and Collector" for collection.

IOLYOKE .... Eight cents per front foot and 5 mills per square foot for area within 120 feet of street, is regularly assessed on abuttors. See No. 15 for exceptions. This method was adopted after considerable thought and study, by approximating the cost of all sewers built in the city prior to time of change in the assessment plan. Since the change no complaints are made, as each abuttor knows beforehand what his assessment will be. A surplus is accumulated by this method, as the assessment is more than sufficient to build ordinary small sewers.

IYDE PARK .... Board of Sewer Commissioners, consisting of three members, lays assessment according to rates which are fixed by ordinance. See No. 15.

AWRENCE .... Assessments are regularly laid by Board of Aldermen at 6.5 mills per square foot for land within 100 feet of street. Many properties (corner lots, etc.) have already been assessed for sewers built under the old system, and paid at a lower rate, varying with cost of sewer. Under present system there is "reserved" on such properties an amount equal to the difference between amount previously paid, and amount due under new system, which "reserved assessment" must be paid before any connections can be made with the new sewer. The property has the right, however, to drain into sewer previously constructed, without additional payment. Where corner lots have previously paid assessments under the present system, they are exempted from the amount so paid.

YNN .... City Engineer makes a table showing amount and location of frontage of each abuttor, and amount assessable on him at 65 cents per front foot. Board of Aldermen make assessment from this table, and give to Collector of Taxes for collection.

IALDEN .... A system of annual sewerage rates is charged as follows: for unoccupied land, 5 cents per front foot. For dwelling houses, $5 per annum, where water rates for preceding year do not exceed $7, with an addition of 20% of the amount by which water rates do exceed $7, but sewer bill shall not be over $15. For estates of over 100 feet frontage on any street, 5 cents per foot is added for such excess. For dwelling houses not using city water, rate is fixed by Street Commissioners according to circumstance.

Instead of an annual rental owners may pay $1 per lineal foot, which shall not cover more than 100 feet in depth, corner lots to be assessed on second street at same rate for all frontage over 100 feet. Land not assessed under above provisions subject to second assessment.

New Bedford	The Board of Public Works exercises the functions vested by General Statutes in Mayor, Aldermen and City Council, and lays the assessments. During the winter City Engineer makes plans of sewers constructed during the year preceding, showing property lines, owners, areas and dimensions of lots, and location of any previous assessment on neighboring sewers. If assessment line is 100 feet, the area of each owner's property between this line and street line is estimated and placed upon plan in red ink. The Clerk of Board of Public Works then ascertains from Assessors their valuation of the land per square rod, also their calculation of the value of the land within the assessment line. One-half the cost of sewer is then divided by the total value of the assessable area on both sides of street, and the unit of assessment thus determined. Any property which has been assessed on any other sewer is not assessed a second time.
Newton	Assessments are computed by City Engineer, who prepares plan of each street, showing new sewers and connections, all other drains and sewers, public and private, and all property with owner's name, frontage and area, and amount assessable on each lot. Assessment is made by Board of Aldermen, according to this schedule.
North Adams	No assessment. Nominal entrance fee only. See No. 15.
Quincy	Under order of City Council, in accordance with act authorizing construction of our system, it was voted that half the cost of the system be borne by city, and balance assessed on property abutting on sewered streets, 20% on frontage and 8% on area within 100 feet of street line. An estimate was made of total cost of completed system, total length of sewers, total assessable area and frontage, and from this the rate of 12 cents per foot frontage and 6 mills per square foot area was determined. Assessments are figured and sent out by Sewerage Commissioners.
Somerville	If cost of sewer is over $2 per lineal foot, city usually assumes excess. Amount assessed is borne half by frontage and half by area within 100 feet of street. After total cost of sewer is ascertained, half is divided by total front feet and half by total assessable area, and the rates thus obtained are used in each case. City Treasurer sends bills and makes collections by order passed by Board of Aldermen.
Springfield	Entrance fees are charged in advance when connection with sewer is to be made. Rates are as follows: for hotels, factories and store buildings, $1.50 per front

foot and $1.50 additional for each foot in depth over 100. Churches and public institutions, $5. Single dwelling houses, where only one family occupies ground floor, $25. Double dwelling houses, built for two families on ground floor, $50. In addition abuttor pays cost of laying connection from sewer to street line.

Taunton .... On receipt of petition to enter sewer, the Commissioners vote what shall be charged as a temporary assessment, which is ordinarily 50 cents per front foot. The privilege is reserved to make assessment or charge rental later, when system is complete and disposal works running. Our sewage will have to be pumped. By ordinance, abuttors are assessable for not less than one-third nor more than three-fourths of total expense.

Waltham .... Of that portion of the total cost which the Board of Aldermen adjudge should be borne by abuttors, four-tenths is assessed on frontage and six-tenths on area, including only land within 150 feet of street which can be sewered.

Worcester .... Three-fourths of cost is usually assessed to abuttors. In case of large trunk sewers or lines that are very expensive, assessment is determined by Committee on Sewer Assessments, as in their judgment it seems best.

RHODE ISLAND.

Providence .... Plans are prepared, usually copies of Assessors plats, showing each lot, with its number, area and frontage. Sheets are prepared, giving names of each lot owner, area assessed within lines as per assessment law, also front feet of lot. This work is done in City Engineer's office and returned to Commissioners of Public Works office, where prices are added and sheets sent to City Treasurer, who advertises assessment as due, and collects it as he does city tax.

OTHER STATES.

Albany .... "Practically explained by Nos. 15 and 16."

Buffalo .... Property on line of sewer assessed by frontage; balance of the sewer district is taxed a nominal amount for surface drainage. All determined by Board of Assessors.

Cincinnati .... When contract is completed, total amount of different items is measured and ascertained and a final estimate made to contractor, according to prices bid. Then total assessable feet frontage is obtained (exempting 100 feet on corner lots), and from this the rate per foot to the property owners is paid to contractor as the city's portion, out of the trunk sewer funds. Payments are optional, either in cash, or on the five years installment plan, at 4% interest.

CHICAGO .... Assessments levied by Board of Local Improvements. All property that is to be drained is assessed according to benefits. Property owners have hearing before Board before ordinance is passed, and later in Court before assessment is confirmed. After confirmation contract is let.

CLEVELAND .... City is divided into districts, according to drainage areas. Uniform assessment of $2 per front foot is charged all abuttors, and excess, if any, raised by general tax on all property in that district.

COLUMBUS .... No assessment can exceed 25% of taxable valuation, unless petitioner waives this provision of statutes, nor can any assessment exceed benefits. It is, therefore, more difficult for assessment to be set aside by Court, if made by benefit in first instance, so in doubtful cases this method is adopted to avoid litigation, though law allows also by frontage or by valuation.

DETROIT .... City pays whole cost of main sewers from annual appropriations by City Council. For laterals, assessment is by area.

MINNEAPOLIS ...... Sewers were formerly assessed at a uniform flat rate of $1.50 per lineal foot, without regard to size, but a recent decision of our Supreme Court has forced us to change the method. Now the assessment is based on the actual cost of a 24" sewer.

NEWARK When a part of a sewer system is built, in which the main sewer is made to carry the surface water of that particular drainage area, the cost of the whole work is distributed over the whole area, but can only be collected from those properties where lateral sewers are built at same time. Where none are laid, that part of the cost is held as a lien until the lateral sewers are built, then without interest for the intervening time.

ROCHESTER All assessments of every nature are made by a board of four assessors, elected at annual election, holding office for a period of four years each. In the case of a local sewer the practice of assessors is to levy the entire cost upon abutting property, in proportion as they consider said property benefited. In getting at benefits to the property they take into account both frontage and depth of lot. In assessing an outlet sewer, Board takes into account benefits of the entire territory that drains through this sewer, and assesses the entire territory for outlet. This assessment is based

	upon both area and frontage. Balance of cost is assessed upon the property that has a direct benefit and can connect directly with the sewer. In both cases there are items of cost that belong directly to abutting property, such as cost of house laterals and Y branches. These amounts are certified to assessors by City Engineer, and charged directly to the property for whose benefit they are put in.
San Francisco	Sewer assessments on abutting property are levied according to frontage; work on crossings on frontage half-way to next street. When sewers are constructed by a district, apportionment of costs is made according to benefits. Usually frontage on new work then pays as much as an 8-inch sewer would cost, rest of expense being apportioned (according to benefits) to all land in district, generally with area as a basis. When owners of private property so desire, permits are issued for construction of sewers in front of their property by contractors selected by these property owners, and in such cases contractors collect directly from owners, rendering an assessment unnecessary.
Washington	Notice is given by advertisement of a hearing by the Commissioners to consider objections to construction of proposed sewer. If none are received, or if in opinion of Commissioners those received are not well founded, the work is ordered, and after construction the account of cost is transmitted by Sewer Department to the Assessor of the D. C., who makes assessments and serves notice required.

18. How is the annual maintenance of the system provided for?

CONNECTICUT.

Bridgeport	By the city alone, under the head of "Sewer Repairs."
Bristol	Not answered.
Danbury	By appropriation by Board of Estimate.
Farmington	Tax list.
Greenwich	General tax.
Hartford	General tax.
Meriden	General tax.
Middletown	General tax.
New Haven	Yearly appropriation.
New London	In city tax.
Norfolk	Annual tax. See No. 17.

Norwalk	Annual tax. A city appropriation is set off each year for the Sewer Department.
Norwich	General tax.
Ridgefield	Borough tax.
Rockville	By special annual appropriation.
South Norwalk	Annual appropriation.
Stamford	By regular tax levied for amount of appropriations made.
Wallingford	By appropriation from general fund.
Waterbury	By annual appropriation.

MASSACHUSETTS.

Boston	Appropriation, general tax levy.
Brockton	By a system of rentals, based on water rates.
Brookline	By an item in general tax levy called "care of sewers," which includes cleaning catch basins.
Cambridge	Appropriation.
Everett	No special provision. Money taken from regular sewer appropriation provided from bond issue.
Fall River	By general tax levy.
Fitchburg	By general tax levy.
Haverhill	By the appropriation for sewers.
Holyoke	The method of assessment provides for maintenance, being supplemented by an annual appropriation charged to general taxation.
Hyde Park	Annual maintenance charge is small, and thus far has been paid out of proceeds from bonds and sewer assessments.
Lawrence	From the regular sewer appropriations, which cover new construction and maintenance.
Lowell	Annual appropriation.
Lynn	Annual appropriation.
Malden	From money received from rates, etc.
New Bedford	Annual appropriation to account of "General Sewers."
Newton	General tax.
North Adams	General tax.
Quincy	General tax.
Somerville	General tax.
Springfield	General tax—annual appropriation.
Taunton	By appropriation. When system is complete we expect to pay for pumping, etc., by rentals.
Waltham	Annual appropriation.
Worcester	Annual appropriation.

RHODE ISLAND.

Newport	By allotment from general appropriation for highways.
Pawtucket	Direct appropriation.
Providence	Appropriation—general tax.
Woonsocket	Appropriation—general tax.

OTHER STATES.

Albany	General tax.
Baltimore	General tax.
Buffalo	General tax.
Cincinnati	General tax.
Chicago	General tax.
Cleveland	Charged to sewer district in which repairs are made.
Columbus	General tax.
Detroit	Annual allowance granted by City Council.
Minneapolis	Part of general taxes set aside for the purpose.
Newark	Appropriation for Sewer Department in annual tax levy.
New York City	By appropriation.
Philadelphia	Annual appropriation to Bureau of Highways.
Rochester	General tax—street and sewer fund.
St. Louis	Annual appropriation from public revenue.
St. Paul	From street, sewer and garbage fund—raised by direct tax.
San Francisco	Annual appropriation — often inadequate — from city funds.
Washington	Appropriation made by Congress.

19. Do you favor making the sewer system self-supporting by some method of direct tax similar to water systems?

CONNECTICUT.

Bridgeport	Yes.
Bristol	Not answered.
Danbury	Not after a property owner has paid an assessment on his whole frontage. If sewer should be built wholly at expense of city, then would favor an assessment for connection and a small annual rent.
East Hartford	Yes.
Farmington	Not answered.
Greenwich	Not answered.
Hartford	No.
Meriden	Under some conditions—yes.
Middletown	Yes.
New Britain	Yes.
New Haven	It might be favorable in case of starting a sewerage system, but not as we are situated in New Haven.
New London	Yes.
Norfolk	Yes.
Norwalk	No—as it would now be hard to change. In one sense our sewers are now supported by a direct tax.

Norwich	Not in a small city where sewers have been building for thirty years.
Stamford	Yes.
Wallingford	No.
Waterbury	No.

MASSACHUSETTS.

Brockton	Yes.
Brookline	No.
Cambridge	No.
Everett	No. The expense of maintenance should be covered by a general tax.
Fall River	"Personally, I do. The powers that be, do not."
Fitchburg	Yes.
Haverhill	Surely not in case of the "combined" system as used here. Possibly, in some cases on the "separate" system, especially where purification is necessary.
Holyoke	Prefer our system of assessments, as there are no complaints, and an annual tax is a perpetual burden. Do not favor a direct tax where it can be avoided.
Hyde Park	No. Think this method too complicated and expensive.
Lawrence	With a small increase in the rate of assessment, our present system would be satisfactory.
Lowell	Not here.
Lynn	Yes.
Malden	No.
New Bedford	Do not think a separate direct tax would make our system, which is very complete and built on the separate system, any more self-supporting than the present method of paying the city's proportion of first cost and the cost of maintenance out of general taxes. In either case it comes out of the property owners, and I do not think that the American people like special taxes.
Newton	No. Not in a sparsely populated city.
North Adams	No.
Quincy	No.
Somerville	Not in this city.
Springfield	This question has not as yet been altogether determined.
Taunton	Yes.
[illegible]	No.

RHODE ISLAND.

Newport	Yes, if adopted when system is built.
Providence	My experience would indicate that such a plan would be more business-like.
Woonsocket	By appropriation for that purpose.

OTHER STATES.

ALBANY	No.
BALTIMORE	Yes.
BUFFALO	Not practical here.
CINCINNATI	No, the conditions are not alike.
CHICAGO	No.
CLEVELAND	I believe in a general levy for sewer purposes.
COLUMBUS	This may be necessary when sewage purification greatly increases the annual charges. Under present conditions would not favor it.
DETROIT	Yes.
MINNEAPOLIS	No.
NEWARK	The other system has been so long in vogue, that a change is hardly advisable.
NEW YORK CITY	Has not been considered here lately.
PHILADELPHIA	No. This would not provide for reconstruction of large sewers that have been worn out.
ROCHESTER	Yes.
ST. LOUIS	Yes, very emphatically.
ST. PAUL	No, sir.
SAN FRANCISCO	No. Maintenance should be a tax upon entire community.
WASHINGTON	No.

20. Has your city adopted, or do they contemplate the adoption of sewage rentals?

CONNECTICUT.

BRIDGEPORT	No to both questions.
BRISTOL	Not answered.
DANBURY	No.
EAST HARTFORD	No.
FARMINGTON	No.
GREENWICH	No.
HARTFORD	No.
MERIDEN	No.
MIDDLETOWN	No.
NEW BRITAIN	Not yet.
NEW HAVEN	No.
NEW LONDON	No.
NORFOLK	No.
NORWALK	No.
NORWICH	No.
ROCKVILLE	No.
SOUTH NORWALK	No.

Stamford	No.
Wallingford	No.
Waterbury	No.

MASSACHUSETTS.

Boston	Adopted in 1897, but statute providing for rental system declared unconstitutional by Supreme Court in 1898.
Brockton	Have adopted rentals.
Brookline	No.
Cambridge	No.
Everett	Unfortunately, system is too nearly completed to reconsider assessment method, though present plan thought to be faulty.
Fall River	Has been contemplated for years, and probably will be for years to come.
Fitchburg	No.
Haverhill	No.
Holyoke	No.
Hyde Park	No.
Lawrence	No.
Lowell	No.
Lynn	No.
Malden	Yes—probably first city to do so.
New Bedford	No.
Newton	No.
North Adams	No.
Quincy	No.
Somerville	Have not as yet.
Springfield	Such method has been contemplated, but not adopted.
Taunton	Contemplate adoption.
Waltham	No.
Worcester	No.

RHODE ISLAND.

Newport	No.
Pawtucket	No.
Providence	No. It may come sometime as the annual expense ha increased, owing to the starting of precipitation plant
Woonsocket	No.

OTHER STATES.

Albany	No.
Baltimore	No.
Buffalo	No.
Cincinnati	No.
Chicago	No.
Cleveland	No.

Columbus	No.
Detroit	Considered, but not adopted.
Minneapolis	No.
Newark	No.
New York City	No.
Philadelphia	No.
Rochester	No.
St. Louis	No.
St. Paul	No, sir.
San Francisco	No.
Washington	No.

21. Does your Sewer Department have a permanent chairman?

CONNECTICUT.

Bridgeport	No.
Bristol	Not answered.
Danbury	No.
East Hartford	Yes.
Farmington	No.
Greenwich	No.
Hartford	Yes—President of Board of Street Commissioners.
Meriden	Yes—the Mayor.
Middletown	No.
New Britain	Yes.
New Haven	Have Director of Public Works; Superintendent of Sewers, who takes charge of sewers when built; new work under charge of City Engineer.
New London	Yes—the Mayor.
Norfolk	Executive Committee of five members organize themselves and manage affairs.
Norwalk	Yes, elected annually. Present chairman is in his sixth term.
Norwich	Sewers built and maintained by Street Department, about which nothing is permanent.
Ridgefield	No.
Rockville	No.
South Norwalk	Sewers under care of Board of Street Commissioners.
Stamford	No.
Wallingford	No.
Waterbury	In charge of Board of Public Works. Has a Superintendent of Sewers.

MASSACHUSETTS.

Boston	Sewer division is part of Street Department, and in charge of a Deputy Superintendent, who is under Superintendent of Streets, who is responsible to Mayor only.
Brockton	Three Commissioners, three-year term.
Brookline	No.
Cambridge	No.
Everett	Chairman of Board of Public Works, elected annually by the four other members.
Fall River	The Mayor.
Fitchburg	No.
Haverhill	No.
Holyoke	Board of Public Works has charge of this department.
Hyde Park	No.
Lawrence	Superintendent of Streets is Superintendent of Sewers, and he is changed as the voters desire a change.
Lowell	No.
Lynn	No.
Malden	Elected yearly.
New Bedford	No. Have a Board of Public Works, which may soon be abolished.
Newton	Chairman of Sewer Committee appointed each year.
North Adams	No.
Quincy	No.
Somerville	No. Chairman of Sewer Committee appointed usually from Board of Aldermen.
Springfield	No.
Taunton	Have three Commissioners. Term three years. They elect their President. But little change in personnel of commission.
Waltham	Superintendent of Sewers, appointed by Mayor annually.
Worcester	Superintendent elected each year. Chairman of Sewer Commission appointed each year.

RHODE ISLAND.

Newport	No.
Pawtucket	Under direct control of Commissioner of Public Works.
Providence	No. Department is under Commissioner of Public Works.
Woonsocket	Chairman elected from three Commissioners appointed annually.

OTHER STATES.

Albany	No.
New York	No.
Buffalo	No.

Cincinnati	No.
Chicago	Superintendent under civil service law.
Cleveland	No.
Columbus	No.
Detroit	No.
Minneapolis	No, changed every two years.
Newark	Under direction of Board of Works.
New York City	At present a Commissioner.
Philadelphia	Department of Public Works, Bureau of Surveys, constructs sewers.
Rochester	Under Department of Public Works.
St. Louis	No. Appointed for term of four years.
St. Paul	In charge of City Engineer.
Washington	No.

22. Does your Sewer Department keep an authentic record of rainfall, for protection of the city in suits, etc.

CONNECTICUT.

Bridgeport	No.
Bristol	No.
Danbury	No.
East Hartford	No.
Farmington	No.
Greenwich	No.
Hartford	Yes. (3) automatic rain gauges.
Meriden	No.
Middletown	No; these are carefully taken and recorded by the Water Board.
Naugatuck	Record of rainfall is kept in the Engineer's office.
New Britain	No.
New Haven	No; we rely on records kept by U. S. Government Weather Bureau office in New Haven.
New London	No.
Norfolk	No.
Norwalk	No. Depend on U. S. Government local records, which are always open for inspection.
Norwich	No.
Ridgefield	No.
Rockville	No.
South Norwalk	No—can get them from U. S. Government station.
Stamford	No.
Wallingford	No.
Waterbury	No.

MASSACHUSETTS.

Boston	Yes, but records of Water Department of Desmond Fitzgerald, C.E., at Chestnut Hill reservoir the standard for this division.
Brockton	Yes.
Brookline	No.
Cambridge	Yes, kept by Engineering Department.
Everett	No; are contemplating the plan now.
Fall River	No. Water Department does.
Fitchburg	No.
Haverhill	Yes. Kept by Engineering Department.
Holyoke	No. But it should be done.
Hyde Park	No. Our sewers are built on the separate system and Sewer Commissioners have had nothing to do with surface drainage, though their act gives them authority so to do.
Lawrence	No. The Essex Co., a land and water power company here, keeps a complete weather record, from which we have in the past got desired information.
Lowell	No.
Lynn	No. Record kept by Water Department.
Malden	Kept by Engineer's Department.
New Bedford	City Engineer keeps rainfall records.
Newton	No. We have separate system of sewers and don't need it.
North Adams	Kept at reservoirs by Water Board.
Quincy	No.
Somerville	Keep measurements of flows in sewers and direct [illegible] for unusual flowage.
Springfield	Kept by Engineering Department.
Taunton	No.
Waltham	Kept by Water Department.
Worcester	Yes.

RHODE ISLAND.

Newport	No.
Pawtucket	Kept by Engineering Department.
Providence	The City Engineer keeps a full set of meterological observations and rain gauges at several points.
Woonsocket	Kept by Water Department.

OTHER STATES.

[illegible]	Kept by U. S. Weather Bureau.
[illegible]	Kept by U. S. Weather Bureau.
[illegible]	No.
[illegible]	Kept by U. S. Weather Bureau.
[illegible]	Kept by U. S. Weather Bureau.

Cleveland	Yes.
Columbus	Kept by U. S. Weather Bureau.
Detroit	Kept by U. S. Weather Bureau.
Minneapolis	Automatic rain gauges.
Newark	Yes, since 1897.
New York City	Kept by U. S. Weather Bureau.
Philadelphia	Records are taken in different parts of the city.
Rochester	Kept by Water Department.
St. Louis	Kept by U. S. Weather Bureau.
St. Paul	Yes.
San Francisco	Kept by U. S. Weather Bureau.
Washington	Yes.

23. Is your method of sewer assessments satisfactory?

CONNECTICUT.

Bridgeport	No.
Bristol	Not answered.
Danbury	As a rule, yes.
Farmington	No.
Greenwich	Yes.
Hartford	Not entirely.
Meriden	Not entirely.
Middletown	Yes, to the majority.
New Britain	Yes.
New Haven	Yes.
New London	Yes, generally so.
Norfolk	I think it is *very satisfactory*, though our system is, of course, new.
Norwalk	We have none.
Norwich	Yes.
Rockville	Fairly so.
South Norwalk	Yes.
Stamford	Fairly so.
Wallingford	Generally.
Waterbury	Seems to be accepted without much complaint.

MASSACHUSETTS.

Boston	No. Far from satisfactory.
Brockton	Yes.
Brookline	As nearly so as it is possible from the point of view of the tax payer.
Cambridge	As much so as any would be likely to be.
Everett	"Not in my opinion."
Fall River	To those who have sewers it is. To those needing them it is not.

Fitchburg	There seem to be no objections by the persons assessed.
Haverhill	Reasonably so.
Holyoke	Thoroughly satisfactory.
Hyde Park	Very.
Lawrence	With wages for labor at $2 per day of eight hours, it is too small.
Lowell	No.
Lynn	Yes, to a majority of citizens.
Malden	Apparently.
New Bedford	We do do not have much complaint from our assessment method, partly because we rarely build a sewer unless it is petitioned for by the abutting property owners, and we never assess more than half of the cost. If we were building extensive additions, irrespective of the wishes of abuttors; and were to assess the entire cost upon abutting property, I think our present method would be very unsatisfactory.
Newton	Generally.
North Adams	Generally considered so.
Quincy	As much so as any.
Somerville	Always has been.
Springfield	In some ways, yes; in others, no.
Taunton	Not quite.
Waltham	No; never saw one that was.
Worcester	No.

RHODE ISLAND.

Pawtucket	Yes, excepting that it may be too low and that it does not provide for maintenance.
Providence	I believe one of the best.
Woonsocket	No complaints have been made as yet.

OTHER STATES.

Albany	Yes.
Buffalo	Yes.
Cincinnati	Yes.
Chicago	Reasonably so.
Cleveland	Not entirely.
Columbus	Fairly so, but accidents of location make material irregularities.
Detroit	Fairly so.
Newark	I have heard nothing to the contrary.
New York City	We have heard of no complaint.
Philadelphia	Yes, as the people are educated to it.
Rochester	No. One objection to this method is that land near head of an outlet sewer district has many assessments

	levied against it for outlet, as both original construction, and re-construction when sewers are outgrown, are charged upon territory deemed by Common Council to be benefited.
St. Louis	No.
St. Paul	I don't think so.
San Francisco	Fairly satisfactory.
Washington	Yes, generally speaking, but as sewers are assessed in accordance with size, assessments are not equalized as to service rendered.

REPORT OF BOARD OF DIRECTION.

At a meeting of the Board of Direction, held in President Vorce's office at Hartford, February 24, 1902, it was voted that the term of office of the four members of the Board of Direction be settled by lot. Messrs. Charles M. Jarvis and Robert A. Cairns were thus elected for two years, and Henry J. Kellogg and Charles H. Bunce for one year. Mr. J. Frederick Jackson was elected to fill the office of Secretary and Treasurer, made vacant by the resignation of Mr. George K. Crandall at the annual meeting.

Clarence B. Vorce,
Frederick L. Ford,
Charles H. Bunce,
Henry J. Kellogg,
Board of Direction.

The Treasurer, Mr. George K. Crandall, submitted the following report:

TREASURER'S REPORT.

For the Year ending February 11th, 1902.

George K. Crandall, *Treasurer, in account with*
The Connecticut Society of Civil Engineers.

RECEIPTS.

Cash on hand January 8th, 1901	$282.16
Received for advertisements	474.00
Received for dues	495.00
Received from sale of reports	4.00
Received from sale of dinner tickets	135.00
	$1,390.16

DISBURSEMENTS.

Janitor at Hartford	$ 2.00
Stenographic reports	71.30
Printing	579.50
Electrotypes	104.74
Postage, stationery, etc.	105.89
Freight and cartage	4.31
Stereopticon	9.00
Dinners and use of rooms for meetings	260.95
Sundries	46.75
Ella A. Fairchild (services by special vote)	25.00
George K. Crandall, salary as Secretary	50.00
Cash on hand February 11th, 1902	130.72
	$1,390.16

Respectfully submitted,

GEORGE K. CRANDALL,
Treasurer.

This will certify that we have audited the accounts and books of George K. Crandall, Treasurer of the Connecticut Society of Civil Engineers, and find the same to be correct.

L. E. DABOLL,
J. FREDERICK JACKSON,
F. L. FORD,
Executive Committee.

On motion of Mr. Graves, it was voted that the report of the Treasurer be accepted and ordered printed in the annual report.

On motion of Mr. Bunce, it was voted that the audit of the Executive Committee be accepted, and ordered printed in the annual report.

The President appointed Messrs. Bunce, Graves and Vorce to act as a Committee on Membership, the regular members of the committee being absent.

The President appointed Mr. Charles N. Crawford and Mr. [illegible] to act as tellers on vote for officers, and Mr. Ford and Mr. [illegible] tellers on the election of new members.

[illegible] Mr. President: the Committee to whom was referred the applications for membership would report that they have examined the applications and find them properly endorsed, and would suggest to the Society that they are proper applicants for admission. The names are as follows: Arthur Stephen Hawley, Malcolm M. Eckhardt, James Francis Shaughnessy, Louis R. Hazeltine and G. E. Verrill.

On motion of Mr. Graves, it was voted that the rules be suspended and the Secretary cast one ballot for each of the candidates.

The Secretary then cast the ballot in accordance with the vote of the Society, and the President declared Messrs. Louis R. Hazeltine, George E. Verrill, James F. Shaughnessy, Malcolm M. Eckhardt and Arthur S. Hawley elected active members.

President Henry M. Kellogg then read his annual address as follows:

It has been one important object of our Society to collect, yearly, as much information, as can be economically obtained, relating to the engineering work done in this State, and outside of this State when the same has been under the direction of members of this Society. Following in the path made by my predecessors, and more closely marked by my immediate predecessor, I had printed and distributed a circular or blank form, which was nearly an exact copy of the one issued last year. The only marked difference was that this year's circular was printed upon one side of the sheet so that the sections could be cut out, assorted, and sent to the chairmen of the different committees. The experience of last year showed that only about 15 per cent. of the stamped envelopes for remailing were returned. Rather than repeat a small extravagance the return postage was this year omitted. There may be a lack of interest on the part of a few, but, I believe, a too modest opinion on the part of many regarding their own work accounts for most of the non-returns. It is natural that members, not engaged in work classed under the various headings, should suppose that no acknowledgment was expected or desired. Another year, if the practice is continued, I hope even such members will send back an answer, as the President feels much responsibility, and every reply brings encouragement with it. This year's result shows improvement. I wish to thank the members generally for their efforts toward the carrying out of the plan adopted. It can be greatly improved. I beg leave to say that, in my opinion, a lesser number of committees would be more economical and fully as effective. The committees on Electric Railways and Steam Roads would better be made into one. Highway Construction and Street Pavements could be put under one committee. Field Work and Office Management, if either are again needed, might as well form one committee's work. The matter of insignia fails to awaken any interest and may as well be laid aside until there is a manifest desire for a society badge. These are matters to be considered and dealt with by the next administration; but I should feel that I had neglected a duty if I did not give public voice to an opinion based on the experience of the past year.

From the information obtained the year of 1901 has been satisfactory to all but two or three, and the prospects for the coming year appear to be bright. The statistics gathered will be compiled by the proper committees and published in our next book.

The meeting held in New Haven last April was more of a success than the special committee had expected. It was held later than the spring meeting of the previous year, and it was feared that the opening of the new season's work would interfere with the attendance. But we were pleased to see that so many members could find time to attend and it is hoped that all felt repaid for their trouble. Mr. Merril Watson, Manager of the New York Expanded Metal Company, and Mr. William M. Bailey, of the Eastern Expanded Metal Company, two of the many allied companies, at my request, gave us an interesting description of the discovery and the use of expanded metal, in combination with concrete, in the construction of buildings, sewers and aqueducts. They were followed by Mr. D. Edgar Manson of the Westinghouse Company, in an excellent description of the works of the Niagara Falls Power Company's plant. Both lectures were profusely illustrated with lantern slides. Our thanks, which we formally expressed in votes, are due to these gentlemen for their personal exertions as well as the considerable expense incurred by them and for which they refused reimbursement. The most pleasing feature of the meeting was the address given by President Hadley of Yale University. He is by official position, intellectual attainments and national reputation, the most important man who has ever appeared before us; and we may feel highly honored that, in the midst of arduous duties, he willingly found time to give us an address that will ever be recalled with pleasure by those who heard it. By making him an honorary member, we also conferred distinction upon ourselves. Professor Chittenden, Director of the Sheffield Scientific School, was also made an honorary member, in appreciation of his many courtesies to us, and of his work as an educator and director of education in scientific branches.

After a trip to the power plant of the Fair Haven and Westville Street Railway, to inspect the two large electric generators recently installed, free transportation being given to us through the kindness of President Parmelee of that road, we sat down to an excellent dinner at the Tontine Hotel. A new feature (for our dinners) was an orchestra, furnished for the occasion by the New Haven members. One of our members, after the dinner, favored us with some vocal selections that deservedly met with great applause. It was just a hint of more sociability and closer intimacy in the future. To use a small and much abused word, a little more "fun" would do this Society no harm. Usually our meetings are marked with much work and too little play.

Following the dinner, the order of the day was the adoption of the new constitution. This was taken up, section by section. The discussion on the different sections and the amendments, before the matter was completed, consumed the time from 4 to 6.45 P. M. It was a disappointment that none of the committee who framed the original draft was present. As it now reads the new constitution is, on the whole, an excellent document with some small faults which a few amendments will remedy. The above mentioned committee, who labored with the work and sent out the copies as proposed, earned as much in thanks as we can give them. The modifications, under the discussion, were few, and one of them, certainly, should be rechanged to the original text. I am free to make this statement, as I am partly responsible for the modification.

Our summer meeting, which was held in the vicinity of New London, last August, and which I can refer to with unqualified satisfaction, was a complete success; rivaling the Holyoke trip of 1899. The whole affair was placed in the hands of New London and Norwich men, at their request, with full power to make all arrangements. They exceeded their privilege by assuming all expenses save a small sum for printing and postage. The perfect weather, throughout the day, relieved the committee of their anxieties and afforded us the opportunity of getting every bit of the enjoyment and instruction for which they had planned. Through the courtesy of the railroad company, extended by Superintendent Elwell, we were given a special train on the new branch along the eastern bank of the Thames river to and from the plant of the Continental Compressed Air Company near Taftsville. There we were initiated into the mysteries of the new and novel method of obtaining and transmitting power by compressed air. The zigzag dam, with its automatic flash boards, the awful depths of the shaft for compressing and collecting the comprised air, the manner of constructing the flexible joints of the pipe line and the other features were inspected, and we received instruction on all points from Messrs. Chandler and Knight of our Society and from Colonel Inslee of the Company. When we returned to New London we were put on board the U. S. Government launch "Castle," which had been assigned to our use for the day by Major Leach. We crossed the harbor to the yard of the Eastern Shipbuilding Company, where two steel ships, designed to be of the largest tonnage of any ships in the world, were being constructed. They are to be of the bilge keel type and are calculated principally for freight-carrying. There it was the order to go-as-you-please, with a warning to keep an eye aloft, while clambering about the open frames of the enormous skeletons, to avoid being hit by falling articles, particularly red hot rivets. No accidents were reported except a scorched spot on one pair of trousers. The President and a few others are especially indebted to the kindness of Mr. Fairburn for being piloted about the shipyard, the forging shop and the templet loft.

From the shipyard the "Castle" took us down the harbor to Fisher's Island to inspect the Government fortifications that were nearing completion: an honor to our Society as being the first party of visitors, large or small, that had been admitted up to that time. On the sail to the Island, luncheon—a bountiful and tasty luncheon—was served on board. It was furnished by the New London contingent and Major Leach. "Rusty Isaac" held a reception—a continuous performance—in the captain's cabin. At the Island a surprise was sprung on us in the shape of a train of small cars, rigged with improvised seats and drawn by a little locomotive, made up to carry us along the narrow gauge track to the different forts and magazines on the Island. As we disembarked onto the Island, each man was watched to detect the forbidden camera. Snap shots are not allowed and cameras are contraband. To be consistent with the regulations, a detailed account of what we saw there would better be omitted in a semi-public paper. I should be remiss if I neglected to state that the descriptions and little talks, given from time to time by Major Leach, were exceedingly interesting and instructive, and where he went we followed like a flock of sheep after a bell-wether. Professor Storrs, Mr. La Forge and Mr. Miller, who have been connected with the work, frequently had subdivisions of the party as listeners. When the little train brought us back to the dock, the Major, finding that we had an hour to spare, ordered that the launch should be pointed off shore and gave us a delightful sail beyond the Bartlett Reef Lightship. Steaming through a fleet of becalmed yachts that were vainly striving to race for cabin trophies, made us still more contented with our lot. So delighted were all with the efforts of Major Leach to entertain us that a spontaneous movement to start a subscription for a loving cup for him was but a natural result. As I did not wish that anyone should feel that he had been "held up" at the end of a day of enjoyment, I advised that the matter be deferred; and if the members continued to feel so disposed, a subscription could be made later, and the gift thus made would be a higher mark of esteem. The feeling did not die out nor abate in the least. When the committee appointed made the move, the subscriptions came in freely. It was the intention to make the presentation a feature of this meeting; but the War Department blocked the game by transferring Major Leach to a far western station, to which he went early last month. On the 4th of last December the Committee, consisting of Messrs. Graves, Storrs, Crandall and myself, with Messrs. Richards and Daboll, waited upon the Major at his office in New London and rather informally presented him with the cup. It was a handsome loving cup from the Gorham Silver Company, selected by Mr. Graves, and inscribed as follows:

"Presented to Major Smith H. Leach by his guests on the occasion of the Mid-Summer Meeting of the Society of Civil Engineers, held at New London and vicinity, on the 27th of August, 1901."

The Major had winded the affair and led us over to the Crocker House, where a dinner had been prepared for us and which was served in a private dining-room. There we were joined by Mr. Hazeltine, a new member. The dinner was a credit to both the Crocker House and our host, and again put the members of that committee in debt to him for another pleasant entertainment.

What has been stated in the foregoing pages is principally historical and reminiscent. It is necessarily so, as this address is a medium for spreading the yearly doings upon the records. Now I would say, as briefly as possible, something about the affairs of our Society. The positions reached by this Society has realized the brightest dreams of the few of us who met in Bridgeport eighteen years ago. The greatest growth has occurred in the last three years. As the Society has grown, the cost of it has grown, but not in the same proportion. The expense account, for necessary items and items deemed expedient, shows a perceptible increase in the yearly cost beyond former proportions of expense to number of members. For the cause, note an example or two: the increase in the size of our annual report, due to the fact that more transpires in a year now than formerly, and which report has always been largely paid for from the uncertain income from advertisements, and also the increase in the distribution of the report, has added to the cost per member. The weight of the later issues, and therefore the postage, are over double those of the books of older times, not so very much older either. That may not sound large, but it makes a direct additional tax on the monies received from dues. In the last three years we have held more meetings and more elaborate ones, and each meeting has sent in its bill to the treasurer. The price of a dinner ticket has not paid the net cost per individual for any meeting held within the last three years. It will not, probably, require further testimony to show that the dues, which formerly were piling up a surplus, may become insufficient to retain the prestige we have and to support the advances we are likely to make. With a Board of Direction, whose powers are greater and whose duties are better defined than those of the former executive committee, a way may be found to keep up the present line of action and continue to progress on the rates now collected. If we cannot, we must do less or pay more. It is a safe wager that the vote, should it become necessary, would be nearly unanimous to advance the dues. We have no use for a large surplus, and a former administration showed both wisdom and boldness by cutting into the surplus that then existed in order to stimulate a little enthusiasm and bring in new and desirable members. A small margin over and above the expenses is sufficient. We now rank with the best local engineering societies in the country; and if it should cost us a trifle more we will gladly meet the expense in order to keep our Society at the top.

Outsiders have often spoken of engineers, as a class, as being dead slow in looking after their general interests. I admit that there seems to be more human inertia in a body of them than in other associations of active, busy men. As a partial explanation it should be stated that a majority of them, by reason of the nature of their work, are servants of large corporations, both private and public. In public works it is frequently the case that a comparatively ignorant man with a political pull stands higher in the regard of governing boards than the engineer with brains, technical training and practical experience, and gets more money for less work. That is enough to take some of the energy out of any man and small pay further prevents its development. Civil service rules have improved the conditions to some extent, and will do more if engineers will assert themselves. We must acquire more professional etiquette and thereby gain more respect for ourselves from others. Observe the benefit such unwritten rules are to doctors and lawyers. This will come by degrees if we choose to work for it. One way is open to us to improve our condition and that is by keeping up an interest in this and kindred organizations; and a very pleasant duty it can be made. Small and constant individual exertion and encouragement to those who have the burden of management to bear is all that is needed. Our Society is well organized and equipped, and well fitted for the work it is intended for it to do. The man who leads a thoroughly self-centered life reminds one of that lower animal who eats its meals with one foot in the trough and accompanies its gustations with grunts of satisfaction. There is no human epitome of that animal in our ranks, but anyone who is willing and satisfied to reap benefits from the labors of others without lending a helping hand, bears a slight resemblance to the animal above mentioned.

I hope that, by next year, we may be able to make our annual meetings extend over more time than a few rapid and intense hours of one day. To give zest to your appetites for the dinner we are about to enjoy, let me remind you that to-morrow is Ash Wednesday and that the long days of Lent are before you.

In conclusion, I wish to thank the members of this Society for their cordial, generous and effective support during the thirteen months of my term of office.

The tellers not being ready to report, the Society took up miscellaneous business.

MR. BUNCE: I have a matter which I wish to lay before the Society. I do not know whether it is exactly the proper time, and I would expect to bring it before the meeting after the Committee's report on the election of officers, but I do not know but it might as well come now as any time. As the Society knows, I was one of the committee appointed to draft a new constitution for the Society. Unfortunately, I was unable to be present at the meeting in New Haven when the new Constitution was under consideration, and at which meeting it was adopted. I had also the further misfortune, this past year, to be the Chairman of the Nominating Committee to nominate officers for this Society, and I am free and frank to say that it was a most unpleasant duty, the most unpleasant one I have ever performed since my connection with the Society. I look upon that method of appointing, or suggesting to this Society, the names of persons to be nominated for the different offices, as one of the most undemocratic and illogical ways that was ever invented by anybody. It naturally follows, and I think possibly and probably the count of the tellers will show, that the names mentioned at the head of each one of this class of officers will be the choice of this Society for the next year. In other words, you have put into the hands of five members of this Society the naming of the officers of the Society. For one, I do not believe in that way of doing business. The one great object which I suppose was sought to be accomplished in the choice of officers of this Society by a letter ballot was to give all the members of the Society, whether they were fortunate enough to be present at the annual meeting, or could not be present, a voice in the naming of the Society's officers, and so far I am fully in accord with it, but the method ought not to continue to be the rule of this Society. And in order to bring this matter before the Society, I now propose the following amendment to the Constitution, which under the terms of the Constitution has to be signed by three active members. This will bring it before this meeting for consideration, and then it will have to lay over for action at some future meeting. In Article IV, Section 11, the second clause in that section reads: "At each annual meeting (except in 1901, when it may be done at any meeting) the Society shall choose a Nominating Committee of five, who shall submit to the Secretary not less than sixty days before the next annual meeting the names of three candidates for each office." It is proposed to amend this as follows: First, that the foregoing clause be stricken out,—in other words, that the Nominating Committee shall be abolished. Then, that the following sentence: "Letter ballots shall then be sent by the Secretary to each member at least thirty days before the day of the annual meeting," be amended so that it shall read "Blank letter ballots containing a list of officers to be voted for shall be sent by the Secretary to each member at least thirty days before the annual meeting," leaving the rest of the section precisely as it is at present.

And then one further amendment, which I think probably is necessitated by an error in printing this Constitution. Under Section 4 of the same Article, which reads at present: "If no candidate receives a majority of the votes for any office, then the meeting shall proceed to vote by ballot for the candidates receiving the highest number of letter votes," to amend by inserting the word "two" before the word "candidates," so that it will read "If no candidate receives a majority of the votes for any office, then the meeting shall proceed to vote by ballot for the two candidates receiving the highest number of letter votes." This is signed, in accordance with the requirements of the Constitution, by C. H. Bunce, Henry J. Kellogg and Edwin D. Graves.

You see the object which we aim at is that the ballot that is sent out shall be entirely a blank ballot, and so give every member of the Society an opportunity to indicate his personal preference for each and every officer that shall be nominated for any office by this Society.

MR. GRAVES: Mr. Bunce has presented this matter very fully, and stated all the points in connection with it very clearly. I simply would like to say that I fully endorse all that he has said. We were together on the Committee which prepared the whole Constitution, and we discussed this very matter carefully, and those of us who were members of the American Society had had some experience with this cut and dried method of nominating officers. It is a foregone conclusion that the names on the ballot will be elected. Therefore, the Nominating Committee names the officers of the Society. We discussed this matter very carefully, and went into it at great length, and we thought had devised a means of securing an expression of the Society as to its preference, uninfluenced by any act of any party. If each man would say whom he wanted for officers, his not attending the meeting would have no influence whatever. We realize that under this there will be quite a number of scattering votes, and there may be no majority for any officer by this method; but at the same time, there would naturally be one or two who would receive a greater number than the rest, and to cover this point, when there is no election by a letter ballot, we provide that this annual meeting shall proceed to elect the officers from those who have received the highest number of letter ballots. I certainly hope that these amendments will be adopted.

THE PRESIDENT: We are ready to hear from any other member on the subject, but if there is no further discussion of the amendments they will be handed to the Secretary and referred to our next meeting.

The tellers then reported as follows on the election of officers:

MR. [illegible]: Mr. President, your Committee has counted the ballots cast for officers of this Society, and would report as follows:

[illegible]

[illegible]	123
[illegible]	55
[illegible]	14
[illegible]	18

For First Vice-President.

Frederick L. Ford	80
A. William Sperry	28
Chas. H. Ewing	8

For Second Vice-President.

Edward W. Bush	58
John K. Punderford	39
Shepard B. Palmer	22

Mr. Clarence B. Vorce was then declared elected President, and Mr. Frederick L. Ford, First Vice-President. There being no majority for Second Vice-President, the Society proceeded to ballot for that office. After five ballots Mr. John K. Punderford was declared elected, the final vote being as follows:

Total number of votes cast	46
Edward W. Bush	7
Shepard B. Palmer	12
John K. Punderford	27

Mr. Punderford was declared elected.

The result of the ballot for Secretary and Treasurer was as follows:

George K. Crandall	107
C. Henry Olmsted	3
Ernest W. Wiggin	4

Mr. Crandall was declared duly elected.

The vote for Board of Directors was then announced:

Charles M. Jarvis	106
Charles H. Bunce	103
Henry J. Kellogg	99
Robert A. Cairns	72
Frederick DePeyster	51

The four highest were declared elected.

SECRETARY CRANDALL: Mr. President, and Members of the Society: I wish to thank you for the expression of your good will as shown by this ballot, but I have found recently that my business will not permit me to continue in office. I am very sorry that I did not find it out before the Nominating Committee made their nominations, and the ballots were sent out, but considerable business has come into my hands since then which will require attention in the spring, and just at that time the duties of the office of Secretary are most arduous in printing the report, so I have decided to withdraw. I had a consultation with the President, and came to the conclusion that a withdrawal was not in order, so I allowed my name to go into the ballot, and having been elected I respectfully hand in my resignation as Secretary and Treasurer of the Society.

MR. BUNCE: Mr. President, I would like to say just a word. I think we shall all appreciate Mr. Crandall's reasons for this action, and I have no doubt I speak the mind of the whole Society, particularly as the vote has already voiced the same sentiment, that as long as Mr. Crandall would agree to accept this position the Society would not think of going elsewhere to look for a secretary and treasurer. Mr. Crandall, in attending to his duties in connection with this office through all of these years, has rendered us most efficient service. I think we need not go back any further than last year, when the report was gotten out at such an early date, and, in view of the amount of work on it, it was a very praiseworthy piece of work. We shall all regret very much to have Mr. Crandall sever his connections, officially, with the Society. I think there can be no doubt or question at all that it will be a very hard matter for his successor to fill his place, and with regret I move that his resignation be accepted.

Motion seconded and passed.

THE PRESIDENT: Gentlemen, you have heard with regret, I know, the resignation of Mr. Crandall, and, in accordance with the Constitution and By-Laws, this necessitates that the Board of Direction shall fill the vacancy. That will be attended to later on. Is there any other business to come before us now?

Meeting then adjourned and the members were taken to the Hartford Golf Club, where an excellent dinner was served.

COMMITTEES FOR 1902.

Sewerage.

William H. Cadwell, *Chairman*	New Britain.
Henry R. Buck	Hartford.
Walter H. Richards	New London.

Steam and Electric Railways.

T. C. B. Snell, *Chairman*	Hartford.
Raymond F. Stoddard	Bridgeport.
Robert M. Rollins	Hartford.

Bridges and Masonry.

Earnest W. Wiggin, *Chairman*	New Haven.
John T. Henderson	Hartford.
Charles F. Chase	New Britain.

Highway Construction and Pavements.

Ralph M. Wilcox, *Chairman*	Middletown.
Frank N. Hoyt	Hartford.
Shepard B. Palmer	Norwich.

Law.

Charles H. Bunce, *Chairman*	Hartford.
A. B. Hill	New Haven.
George K. Crandall	New London.

Water Supply.

William E. Johnson, *Chairman*	West Hartford.
George H. Bishop	Middletown.
Charles E. Chandler	Norwich.
George L. Blakeslee	Waterbury.
Charles N. Wood	Norwalk.

AFTERNOON SESSION, 3 P. M.

Convention called to order at 3 P. M., President Kellogg in the chair.

The President: If you will come to order we will listen to a paper by Prof. J. C. Tracy.

AESTHETIC ELEMENTS IN ENGINEERING DESIGN.

By J. C. Tracy.

> "Now it seems to me that what has remained to us as the good genius of our age is just a mathematical element of exactness, neatness, concise clearness and simplicity, supple versatility and pruning away of all superfluities. As compared with the roundabout procedure and awkwardness of innumerable regulations of earlier times, what a preference do we now see for that elegance which characterizes the most concise solutions of difficulties! What brief and severe simplicity do we see in the structure of machines! What vast effects produced by the combination of simple means!
>
> Undoubtedly there is beauty even in this, and may we rejoice heartily in that genius of modern times which, no longer wearing antique draperies or dreaming through life with flowing hair, goes with shorn locks and close fitting garments, and may we hope that it will raise from this small germ a mighty tree filling life with fresh beauty."—Lotze, *Microcosmus*, Book VIII, Chap. III.

The civil engineer has paid more attention to the true and the good in engineering design than to the beautiful. Accuracy, strength, safety (the true); utility, fitness, economy (the good)—these are the watchwords in his work. Busy with those forces which act in strict accordance with well defined laws, and with such solid materials as stone and steel, the modern engineer has had little time to give to that ethereal thing called beauty. The needs of men must be met first, and beauty is a luxury, not a necessity. But as soon as a people has become prosperous and has amassed wealth, the love of beauty manifests itself and a period of art activity begins. This activity is not confined to music, painting, architecture and the other fine arts, but it permeates the whole national life. The awakened sense of beauty on the one hand, and the quickened "art [illegible] on the other, combine to raise the aesthetic level of the whole world. Appreciation of the beautiful is found to some extent in every normal human being, and the "art impulse" in man is as inherent and simple as is the "play impulse" in children. Now the art impulse is the longing to produce something beautiful with no thought of personal gain, and no

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[illegible] and other writers on aesthetics derive the "art impulse" [illegible] impulse.

desire beyond the successful completion of the work.[*] Prosperity and wealth stimulate art activity, not by offering pecuniary rewards to the artist, but by providing him with means to carry on his work. This is especially true in architecture where prosperity enables a people to gratify its love for beautiful buildings, and furnishes the architect with means to express that "vague and indefinite but passionate longing"[†] within him. Thus, in any art, it is the interplay of "art appreciation" and "art impulse" which produces aesthetic results.

No engineer prefers to design an ugly structure if he can just as well design a beautiful one. Moreover when, in engineering, beauty has commercial value as it has in architecture, he cannot afford to neglect the aesthetic elements in his design, or, to put the matter on a little higher plane, the willingness of a people to pay for aesthetic results makes it easier for an engineer to gratify his own sense of beauty in his work.

The development in architecture from the mud hut to the palace was a development from the merely useful to the useful *and* the beautiful. A similar development is now taking place in engineering design, although perhaps it has hardly begun in this country. Little concerning aesthetics is to be found in engineering literature, but it does not follow that the subject is of no importance to engineers. Engineering literature is sometimes a rather tardy reflection of engineering activity.

Perhaps the aim and scope of this paper should be defined at this point, at least in a negative way. It is not an attempt to point out aesthetic defects in engineering design; it is not even an expression of what the author feels is or ought to be beautiful. It is not an effort to formulate a set of fixed rules by which aesthetic results in engineering design may be attained. It is rather an attempt to suggest how the engineer can bring himself into closer touch with the science of aesthetics.

If, as we are told, Aesthetics is the Science of Beauty, it would seem as if its first business were to determine the nature of Beauty, and this is just what writers on aesthetics have been trying to do ever since the days of Plato. A surprising amount of human thought has been given to the study of beauty, and the student of aesthetics finds that his quest is among the ruins of countless exploded theories, where much of the debris is of little value to him. When it is remembered, however, that many of the greatest thinkers the world has known have contributed to the science of aesthetics with such indefinite and unsatisfying results, the elusive nature of beauty is made clear. And if the engineer is impatient because aesthetics seems to have accomplished so little of practical value, it is well to remember that beauty cannot be measured with a steel tape, or subjected to chemical analysis, or put into a machine and tested.

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[*] "So far as he (the artist) learns to calculate and mould his work to bring nearer to him a preconceived benefit to himself, so far is he led by other than the true art impulse."—Henry Rutgers Marshall in *Pain, Pleasure and Aesthetics.*

[†] See "Introduction to Philosophy," by Prof. G. T. Ladd, page 334.

Writers on aesthetics may be divided into three classes, viz.:

(1) Those who try to find in beautiful objects some special quality or qualities common to all beautiful objects and therefore essential elements of beauty, the lack of which in any object prevents it from being beautiful. This is the purely objective method.

(2) Those who look for the true nature of beauty in the mental state of the observer. They deny that the object has beauty in itself, but that it is beautiful because men judge or feel it to be beautiful. Hence it is the observer and not the observed which must be studied. This is the purely *subjective* method.

(3) A [illegible] of those who combine the two methods. [illegible] the beautiful objects have [illegible] must be taken into account, while [illegible] that the sense of beauty in man [illegible]

[illegible] other are easily traced [illegible]

[illegible] of proportion and of order. [illegible] It is not surprising [illegible] idealism, failed to give a

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[illegible] of beauty held by writers [illegible] will be found in the first [illegible] William Knight and also [illegible] treatise is that by Bosan- [illegible] has derived from these works [illegible] here given.

clear and elaborate theory of idealism in Art (although he discusses Absolute Beauty), while Aristotle, in a decided reaction from idealism, recognizes no philosophy of the Beautiful, and lays emphasis on such objective qualities as symmetry and order. Little of value concerning beauty is to be found in Latin literature, or in that of the long period between ancient philosophy and the reaction to idealism, which began in Germany in the sixteenth century. It was Baumgarten (1714-1762), a German, who created aesthetics as a science and gave to it its name. He believed that subjectively the apprehension of the beautiful was a matter of intellectual activity, but he ignored the side of feeling or emotion. Baumgarten was followed by a long line of German writers who recognized in aesthetics a distinct branch of knowledge.

Winckelmann (1717-1768), author of the first German work on the history of art, which Professor Knight pronounces "an almost epoch-making book," held to an *ideal* of beauty produced "by the selection of the most beautiful elements, and their harmonious union, and which exists not in outward nature but in the mind alone." Mendelssohn (1729-1786) continues the reflective analysis of beauty and points out that the pleasure derived from contemplating the beautiful is widely separated from desire. He writes: "This is the mark of the Beautiful that we contemplate it with quiet satisfaction. It pleases us though we do not possess it, and can never possibly make use of it."

Kant (1724-1804), greater than any of the preceding German philosophers, seizes upon Mendelssohn's idea of disinterested pleasure and attempts to explain upon what ground judgments as to the beautiful can be universal and valid, but his theory, elaborate as it is, is incomplete and defective.

Schiller (1759-1805), in the main a follower of Kant, though dissenting on some points, was the first to give prominence to the "play impulse," from which certain modern writers have derived their theory of the "art impulse." Schelling, in his *Aesthetik* (written in 1802), in a reaction from the purely subjective position to which Kant's doctrines had been brought by his followers, attempted to establish some relation between the *object* and the *subject*, between the *real* and the *ideal*. Hegel, who wrote perhaps the most elaborate German treatise on aesthetics, Schopenhauer, Hartman and Lotze, to say nothing of many writers of less renown, brought the philosophy of the beautiful in Germany down to the present time. Interesting and valuable as their writings are from the point of view of philosophy, it must be admitted that no general agreement as to the nature of beauty is to be found in them.

French writers on aesthetics are for the most part followers of one or the other of the German schools. In England, however, the discussion of beauty is along many different lines. At first Lord Shaftesbury and other early writers continue the subjective analysis, while Hogarth, Burke, and their followers, attempt to establish objective qualities of beauty.* The discussion then turns to one of taste,† and finally some of the more recent writers attack the problem from the standpoint of psychology and physiology.‡ The "art impulse" as derived from the "play impulse," and the place of pleasure and pain in aesthetics, now become subjects for study. In the meantime such writers as Carlyle, Ruskin and William Morris had aroused in England a new appreciation of beauty in the fine arts.

In America writers on aesthetics§ have not in most instances attempted an exact definition of beauty; they prefer to discuss where it may be found, rather than what it is. Among the most recent and suggestive books published in this country are Satayana's "Sense of Beauty" and Marshall's "Pain, Pleasure and Aesthetics." In the latter book Mr. Marshall differentiates the mental states of pain and pleasure from all sensations and emotions, and gives an elaborate theory of the relation of this "pleasure-pain" feeling to aesthetic impression.

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* Hogarth's objective qualities: fitness, variety, uniformity, regularity, symmetry, simplicity.

Burke's subjective qualities: smallness of size, smoothness of surface, variety of outlines in curves, delicacy suggesting fragility, brightness and softness of colors.

† "Of the Standard of Taste," Hume, "Essay on the Nature and Principles of Taste," Alison, and many other English writers, including Jeffrey, Stewart, Hazlitt and Hamilton.

‡ "Principles of Psychology," by Herbert Spencer, "Studies in Psychology and Aesthetics," by James Sully, and "Physiological Aesthetics," by Grant Allen.

§ Among American works dealing with aesthetics are two essays, "Nature" and "Conduct of Life," by Emerson, "Aesthetics or the Science of Beauty," Bascom, "The Science of Aesthetics; or the Nature, Kinds, Laws and Uses of Beauty," Day, "The Beautiful and the Sublime, an analysis of the emotions, and a determination of the objectivity of Beauty," Kedney, "Introduction to Philosophy" (Chap. xii, on "Aesthetics"), Ladd. See "A Guide to the Literature of Aesthetics," by C. M. Gayley, University of California, for a complete list of English, German, and French works.

There are some conclusions derived from a study of aesthetics, as found in all these writings, which will clear the way for the application of aesthetics to engineering design.

The first is, that beauty cannot be defined.

(I) It cannot be defined objectively because if we try to say Beauty $= A + B + C + D +$ etc. (in which the constants A, B, C, D, etc., stand for objective qualities), we shall find (1) that A, B, C, etc., themselves cannot be defined, and that (2) any one can be omitted in certain cases and an object still be beautiful. Thus if A = Symmetry, B = Proportion, C = Grace, D = Harmony, and so on, we know not how to define True Proportion, Grace and Harmony. Even if we can define an element, as for example symmetry, we find that it is not always essential to beautiful objects, hence in some cases A may be omitted from the equation. The same is true of B, or C, or D, and so on. Moreover the + etc. stands for innumerable qualities, hence the definition cannot be comprehensive. In the objective definition, therefore, we have at the same time too much and too little. Thus, as stated by Lotze (Outlines of Aesthetics), "we soon become convinced that what we are looking for as the beautiful in itself, as a common characteristic in the different beautiful objects, can neither be a definite property, nor a sum of such properties.

(II) Beauty cannot be defined subjectively, because if we try to say

$$\text{Beauty} = X + Y + Z + \text{etc.},$$

in which the variables X, Y, Z, etc., are characteristics of the *mental state* of a man when contemplating the beautiful, we shall find that these variables are as elusive as were the constants A, B, C. They can neither be defined themselves, nor are they all always present in aesthetic feeling. For example, if X stands for the element of association, (1) what *is* association? (2) Are there not aesthetic impressions in which the element of association seems lacking, as, for example, when a rainbow is seen for the first time? Moreover, as Haslitt pointed out, "If there is a pleasing association there must be first something *naturally* pleasing."

Again if $Y =$ disinterested pleasure, (1) what is pleasure, and when is it disinterested? (2) All disinterested pleasure is not aesthetic pleasure. (3) Is not aesthetic pleasure often so closely linked with pleasure which is not disinterested (as, for example, pride of possession), that the two cannot be separated? Finally, if $\text{Beauty} = X + Y + Z + \textit{etc.}$, the *etc.* stands for innumerable characteristics and hence the definition cannot be comprehensive.

Perhaps Goethe (1749-1832) was not far wrong when he said:

> "Beauty is inexplicable: it is a hovering, floating and glittering shadow, whose outline eludes the grasp of definition." And again: "Mendelssohn and others tried to catch Beauty as a butterfly, and pin it down for inspection. They have succeeded in the same way as they are likely to succeed with a butterfly. The poor animal trembles and struggles, and its brightest colors are gone; or if you catch it without spoiling the colors you have at best a stiff, awkward corpse. But a corpse wants the life which sheds beauty on everything."

There is a warning also for all students of aesthetics in Goethe's thought that there are many "who hit the truth with their feelings, but often lose it again through their reasoning."

If the nature of beauty cannot be determined by the purely objective method or the purely subjective method it would seem that a combination of the two might promise better success: that a discussion of the Aesthetical Ideal might give some definite and valuable results. But to quote Prof. Ladd:

> "When we consider the treatment which philosophy has actually given to the Aesthetical Ideal we are obliged at once to admit its indefinite and unsatisfying character. Results from reflective analysis attained by none of the so-called systems are beyond reasonable doubt in respect to important matters. This is due in part perhaps to imperfect analysis, in part to the very nature of the subject and to the attempt to explain more than it is right to even hope to explain."

Discouraged in the chase of this particular butterfly of beauty, some writers on aesthetics have taken up the discussion of taste. The old saying "De gustibus non disputandum," seems at first thought to be offset by everyday experience. It would seem as if there were *some* basis for fixed standards of taste. Taking an example from each of the five senses we should expect the *average* man to prefer the moderately sweet to the intensely bitter, the softness of the sealskin to the harshness of sandpaper, the fragrance of the rose to the smell of the onion, the music of a pipe organ to the noise of the buzz saw, and the beauties of a sunset to a dull and dreary sky. On the other hand it is to be remarked, (1) that we may pass from either of these extremes to the other so gradually that we do not know when we cross the dividing line, and much in art lies in this realm of "means between extremes." (2) That true art is not to be judged by the average man, and that the verdict rendered in matters of taste by the majority of men is not always a true one.

It would seem, therefore, as if abstract discussion of taste were as futile as the discussion of beauty and for much the same reasons. Tolstoi in his book "What is Art," page 41, puts it thus:

> "But all attempts to define what taste is must lead to nothing as the reader may see both from the history of aesthetics and experimentally. There is and can be no explanation of why one thing pleases one man and displeases another or vice versa. So that the whole existing science of aesthetics fails to do what we might expect of it, being a mental activity calling itself a science, namely, it does not define the qualities and laws of art, or of the beautiful (if that be the content of art), or the nature of taste (if taste decides the question of art and its merit), and then on the basis of such definitions acknowledge as art those productions which correspond to these laws, and reject those which do not come under them. But this science of aesthetics consists in first acknowledging a certain set of productions to be art (because they please us), and then framing such a theory of art that all those productions which please a certain circle of people should fit into it. There exists an art canon, according to which certain productions favored by our circle are acknowledged as being art,—Phidias, Sophocles, Homer, Titian, Raphael, Bach, Beethoven, Dante, Shakespeare, Goethe and others,—and the aesthetic laws must be such as to embrace all these productions. In aesthetic literature you will incessantly meet with opinions on the merit and importance of art, founded not on any certain laws,—by which this or that is held to be good or bad, but merely on the consideration whether this art tallies with the art canon we have drawn up."

We have thus far arrived at two conclusions, (1) that aesthetics has not defined beauty nor, (2) established standards of taste. If these conclusions be correct it follows, (3) *that aesthetics has not furnished a set of rules for obtaining aesthetic results.*

Indeed Bosanquet frankly states, in the preface to his "History of Aesthetics," that "Aesthetic theory is a branch of philosophy, and exists for the sake of knowledge and not as a guide to practice," and insists that "the aesthetic philosopher does not commit the impertinence of invading the artist's domain with an *apparatus belli* of critical principles and precepts. The opinion that this is so draws upon aesthetics much obloquy, which would be fully deserved if the opinion were true."

Prof. Ladd writes:

> "The education of judgment in matters aesthetic can neither begin nor proceed through the communication of rules for correct judgment. You may tell me that this or that object is beautiful, and assure me that I ought to know and feel it to be beautiful; but if I assent and say 'It is indeed beautiful,' when as yet the object has aroused in me no pleasurable appreciation of its beautiful qualities, I mean nothing of which aesthetics takes account. I mean something different from and far less than you wish me to say. The only recognized right standard of judgment in matters of aesthetics is, therefore, the pleasurable feeling of appreciation in those who have most cultivated this feeling." *Introduction to Philosophy*, p. 331.

Mr. Marshall may have the same thought in mind when he makes the somewhat sweeping statement:

> "A great deal of attention has been given by thinkers in the past to the subject of aesthetics, but for all that we find ourselves to-day without any science of aesthetics, and without any philosophy of art which is comprehensive and widely acknowledged as valid."

It has seemed worth while, even at the risk of being tedious, to give you a glimpse of the difficulty aestheticians have experienced in trying to determine the nature of beauty and the standards of taste, and to point out that too much should not be expected of aesthetics in the way of rules for guidance in practice. There is so much mysticism about art criticism. The positiveness with which the art critic gives his verdict leads one to infer that there must be a science upon which he bases his criticisms, but the frequency with which such critics radically disagree, leaves the impression that if there is such a science it is not a very exact science. To the average man the study of aesthetics is valuable chiefly in clearing away some of this mysticism. It will teach him that the nature of beauty and the standards of taste cannot be categorically defined, and that if any general agreement is reached it must be along broad lines. It teaches him the futility of trying to force aesthetic standards upon others, and subdues in himself the spirit of intolerance. It teaches him that after all the so-called "laws of aesthetics" are empirical, *not* theoretical, derived from experiments in which the whole world is the laboratory, and tested by the judgment of men. They are, therefore, subject to modification and often broad interpretation.

It is true that each of the fine arts has its axioms and rules for producing what *ought* to be beautiful, and in *every* form of art there are certain masterpieces, but the rules are largely negative, merely telling what to avoid, and the most trustworthy judges fail to agree in *what* it is that is really beautiful in the masterpieces. Even in architecture a mere application of rules or a combination of them will not result in a beautiful building unless the architect has in him a true sense of beauty. It is well that it is so. If in our work everything could be done by rule, no judgment required, and all chance of mistake eliminated, what machines engineers would be and how monotonously dreary would be our life. And if beauty could be attained by rule how monotonous would be all art.

In view of what has been said it may seem decidedly inconsistent to devote the remainder of this paper to the treatment of some of the objective aesthetic qualities which the engineer should seek to incorporate in his design. But as these elements of aesthetic design are taken up one by one, it is hoped that the aim of the author as thus unfolded will appear to be *not* an attempt to lay down hard and fast rules, but rather to suggest the lines along which the development of aesthetics in engineering design is likely to proceed. It will be seen that the problem is to a large extent *the elimination of non-aesthetic features.* The improvement in design will be a gradual process of evolution in which aesthetic features will survive because they please, while the non-aesthetic features will gradually disappear. *Positive rules, therefore, should be introduced with caution lest they actually retard this natural process of elimination.*

Turning now to the more practical side of aesthetics in designing, the first two elements to be considered are utility and stability.

UTILITY.—In the recently published "Dictionary of Architecture and Building" there is this statement: "The first consideration is utility, and, as to construction, that it should be governed by stability. Beyond this there is no agreement as to elements and no recognized basis of criticism other than that of archæological correctness."

If recognized usefulness is essential to architectural beauty, it is obviously essential tô beauty in engineering structures. Usefulness in itself may not be so important in aesthetic impression as is the presence of the useless detrimental to it. A *useless* thing prominent in any engineering design gives a shock which will mar, if not prevent, aesthetic impression.

Few will agree with Ruskin (Lamp of Architecture), when he says that it is the addition of the *useless* features such as mouldings and carvings which makes architecture more than mere building.

Instead of emphasizing the useless, the engineer must avoid it altogether unless it can be made to appear useful. Mouldings and copings, for example, may not be useful, but they appear to be useful because they seem to unite the structure horizontally.

> "The needs and pleasures of man are the environment to which the structure must be adapted. Determinate forms thus establish themselves and the eye becomes accustomed to them. The line of use, by habit of apperception, becomes the line of beauty." Santayana in *The Sense of Beauty*, p. 162.

It is doubtful if the engineer is ever justified in sacrificing utility for beauty. The true solution lies in making the useful beautiful. Victor Hugo's words, that the beautiful is as useful as the useful, will then be true in a broader sense than he intended.

STABILITY.—The feeling of fear is fatal to pleasurable impression, hence a structure which appears to be unstable cannot be beautiful. So careful were the Greeks in this respect that even in their sculpture careful measurements reveal the fact that the center of gravity of a figure, poised, for example, on one foot, is exactly where it should be.

The too flat elliptical arch, or one with little depth at the crown, is rarely pleasing when it supports a heavy load, even though theoretically it is safe. The abutment from which an arch springs, or a pier between two arches, should be massive so that it may convey the impression that the thrust is amply provided for. Many arch bridges, though perfectly safe, are aesthetically defective in that respect.

Broad foundations and a decided batter in high masonry abutments, piers or retaining walls are aesthetically pleasing because they increase the *sense* of stability as they do in fact increase stability itself. Emphasis of horizontal courses or lines near the base of any structure conveys the impression of uniform distribution of load, and hence is pleasing. Thus it is that in designing structures to carry loads the engineer must be governed not alone by laws of statics, but by the law of aesthetics, that the *sense* of security and stability may also be gratified.

PROPORTION.—After utility and stability there are several elements of aesthetic design about equally important. One of these is proportion. Limited in his use of color and material, the engineer must depend upon proportion as much, if not more, than the architect.

Proportion is based on mathematical principles, yet all attempts to establish fixed rules are incomplete and unsatisfactory. Like beauty itself, proportion escapes analysis. No nation has had the knowledge of it shown by the Greeks, and Classic Architecture has been called, because of its mathematical properties, "Frozen Music." And so their sculpture and architecture alike have been subjected to careful measurements in the hope that the art of proportioning might be re-discovered, and many surprising and useful results have been obtained. For example, in the Parthenon it is found that many proportions have a common difference of five, as 2:7, 4:9, or 9:14. Books full of like results determined by actual measurement, have been published. Standards thus established are valuable as far as they go, but they are variable and must, in most cases, be adapted to modern conditions. To quote Prof. Raymond:

> "I believe," says the Greek scholar, "in using the proportion 7:12 or 9:14, because the Greeks used it. This kind of argument may do for a pedagogic Hellenist, but it will not do for a practical architect. If the Greeks used this or any other proportion, they had a reason for doing it. If the architect of our day uses it without this reason he will use it irrationally and very likely erroneously."*

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* From *Proportion and Harmony of Line and Color*, by Raymond. A very complete treatise on proportion.

Attempts have been made to determine experimentally what in given instances are the most pleasing proportions. Fechner, for example, by testing a large number of people tried to establish the "golden cut" or the most pleasing proportions into which a straight line could be divided, and also what proportion, height to length, a rectangle should have. But such experiments have as yet been of little practical value.

Ruskin says, "The man who has eye and intellect will invent beautiful proportions and cannot help it, but he can no more tell *us* how to do it than Wordsworth could tell us how to write a sonnet."

Nevertheless Ruskin thinks two or three general laws of proportion worthy of mention. He points out the connection of proportion with *vertical* division, holding that buildings or parts of buildings should never be divided *vertically* into halves, thirds, or other equal parts. He thinks that proportion is between three parts at least; that it is not enough to divide a building unequally, but that it must be divided into at least *three* parts. And finally he believes "that all that has been written and taught about proportion, put together, is not to the architect worth the single rule, well enforced, 'have one large thing and several small things, or one principal thing and several inferior things, and bind them well together.'" (Lamp of Beauty.)

Ruskin states elsewhere that it "is just as rational an attempt to teach a young architect how to proportion truly and well, by calculating for him the proportions of fine works, as it would be to teach him to compose melodies by calculating the mathematical relations of the notes in Beethoven's Adelaide or Mozart's Requiem." Such a statement as this is but half the truth, and by ignoring the other half it may lead the reader to a contempt for all fundamental rules. As Beethoven must have had a knowledge of the fundamental laws of harmony, so the designer must acquire a knowledge of the laws of proportion. The engineer who does not have it by intuition, may at least become familiar with pleasing proportions and with fundamental laws as pointed out by writers who have examined masterpieces with this end in view. In this way one may bring his sense of proportion under conditions for proper development and growth, even though he may not discover many fixed laws. It is difficult to see what else [illegible] an do.

SYMMETRY.—Symmetry was made much of in Greek architecture, and was thought by Aristotle to be an essential element of beauty, but much that is beautiful is *un*symmetrical, especially in nature. Nevertheless it is probably true that in most engineering design it is an important aid to aesthetic results. Its value lies largely in gratifying the expectation which one has of finding in certain artificial objects a balance between right and left parts. It is significant that the necessity for vertical symmetry is not felt, and that the absence of symmetry in very small or very large and diffuse objects is not noticed. While proportion is connected with vertical division, symmetry is connected with horizontal division. "Evidently," writes Ruskin, "there is in symmetry a sense not merely of equality, but of balance. Now a thing cannot be balanced by another on top of it, though it may by one at the side of it." Santayana notes, "that the comfort and economy that comes from muscular balance in the eye is, therefore, in some cases, the source of value of symmetry," a theory that has a close relation to the pleasure-pain theory of Marshall. Unity, another aesthetic element, is often secured by use of symmetry.

When symmetry is undesirable or impossible the engineer can often resort to the principle of balance. The ups and downs, or the rights and lefts of a structure, may *balance* each other even though absolute symmetry may be out of the question.

GRACE—MASSIVENESS.—Grace and Massiveness are in a sense opposites, not that a graceful thing may not be massive, or vice versa, but usually if an engineer cannot get one effect in his design he can get the other.

Grace in itself is pleasing, but it must not be attained at the expense of the sense of stability. It often results from good proportions, but not always. Ruskin remarks (St. Mark's Rest, Chap. II), that, "an elephant is as properly made as a stag but he is not so gracefully proportioned. In fine architecture, and all other fine arts, grace and propriety meet."

Physiologically, grace is probably pleasing because of the ease with which the eye follows a graceful line without shock, and because of the rhythmic movement set up by undulating curves. (Like the rhythm in music.) Massiveness, on the other hand, if rightly used, promotes sense of stability. It is not difficult to see why an architect accustomed to mass, would hesitate [illegible] bridge [illegible]—[illegible] On the other hand [illegible] impressed [illegible] graceful curve. [illegible] stimulated in that direction. The [illegible] an example of the happy combination of [illegible]. While it is not always possible to [illegible] it would seem that when either [illegible] the nature of the design [illegible] made toward the effective use of [illegible].

[illegible] held that beauty was always [illegible] simplicity does not mean necessarily [illegible] of parts [illegible] the sense of being opposed to [illegible] of parts and details, or to that which is excessively ornate.

The simple effect is often obtained only by a most careful adjustment of parts so that the whole, while really complex, appears simple. Its order and meaning can be seen without painful exertion of the eye, or too prolonged attention to detail. Simplicity is often therefore restful—at once one reason why it is pleasing and a criterion for its use. Even if ornamentation is used its effect should be simple—readily perceived and understood.

It is a cause for congratulation that the training of an engineer [illegible] a dislike for "frills" and useless, meaningless [illegible]. It is no longer considered in good [illegible] drawings [illegible] and plain [illegible] maps and charts.

[illegible] engineers [illegible]

[illegible]

other direction. The sooner the charm of simplicity is more generally felt the sooner will disappear the gaudy gingerbread work on our houses, and the equally bad decorations and cheap ornament so common everywhere.

UNITY.—Aesthetics makes much of *unity*. Unity in Variety, Unification of the Manifold, Multiplicity in Uniformity, are constantly recurring phrases in aesthetic writings which are self-explaining. Democracy, for example, has been called an attempt at the unification of the manifold, and the stars at night are a beautiful illustration of multiplicity in uniformity. (See *Sense of Beauty*, p. 100.) Symmetry, proportion, and harmony are all powerful aids to unity. Repetition at regular intervals of a prominent detail, corresponding to repetition of prominent chords in music, contributes to music as well as to rhythm. But this may be carried to excess because pleasant repetition too prolonged may fade into painful monotony—another illustration of the pleasure-pain theory. Once the attention of the engineer is called to the importance of unity in design it is comparatively easy to attain it.

FORM.—Pure form or outline involves symmetry, proportion and other qualities already considered, but certain standard, geometrical forms should be mentioned. The rectangle or square is symmetrical, and a rectangle may be well proportioned, but both lack continuity. There is a complete break or shock to the eye at each corner. "The circle is wonderful in its simplicity, symmetry, purity and continuity, but it lacks variety." The ellipse has all these qualities. Santayana (*Sense of Beauty*) states that the circle "is often ugly in vertical surfaces where it is not always seen in perspective. For horizontal surfaces it is better" because, it may be inferred, perspective changes it to an ellipse.

STRUCTURAL LINES.—In architecture emphasis is placed on structural lines, that is the lines along which internal forces or stresses act. A simple example given by Lotze in *Outlines of Aesthetics* is the fluting of columns, and vertical slitting of triglyphs in Greek architecture, where the lines or direction of force (vertical) is indicated by *multiplication* of contours (vertical lines). He further calls attention to the fact that the Greeks made the opposition between support and load prominent, and quite commonly sought a clear delineation of the ends of each single member. Thus the end of a column was emphasized shortly before its occurrence by a horizontal ring or succession of rings, as, for example, the astragal, while a plate (abascus) separated support from load (column from entablature). We see examples of emphasis of structural lines all about us. Indeed it is one of the beauties of the arch that it indicates in itself the line of force within it.

While the principle of making structural outlines conform to existing stresses is important, it cannot be relied upon to create aesthetic impression. The ugliness of the Forth Bridge is somewhat modified in the mind of the engineer when he considers how well adapted are the great cylindrical lower chords in the cantilevers to compression, and the latticed boxed girders in the upper chords to tension,* but this analysis of stresses is seldom present in the mind of the ordinary observer. On the other hand, it is equally dangerous aesthetically to insert "for looks" a member which takes no stress. In one of the largest and most costly churches in New England there is an amusing example of members inserted for "architectural effect." From the top of each of the tall columns supporting roof trusses a heavy brace was extended to the side wall. It was evident that it could take no stress, but if there had been compression in it, at all in proportion to the size of the brace, either the column would have been pushed over, or a hole punched through the side wall.

DETAILS—DECORATION.—It is obviously narrow to condemn all decoration. Ruskin, lover of decoration, writing of modern architects, thunders in his blunt and impulsive way:

> "Not being able to decorate the block when they have got it, they declare that decoration is a 'superficial merit.' Yes, very superficial. Eyelashes and eyebrows, lips and nostrils, chin-dimples and curling hair, are all superficial things, wherewith Heaven decorates the human skull: making the maid's face of it, or the knight's."

It may be noted in this, his own illustration, the beautifying features are useful *not* useless, as Ruskin would have the distinguishing ornamental features of architecture.†

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* See Mr. Baker's defense of the Forth Bridge from the point of view of aesthetics.

† For extreme views of Ruskin on the importance of detail, and what is and what is not ornament, see *Seven Lamps of Architecture* (especially Lamp of Sacrifice and Lamp of Beauty), also *Stones of Venice*.

Whatever may be the eventual outcome, for the present the engineer cannot depend upon ornamentation, and must use it sparingly. Remembering that such details as he may use are to be seen from a distance, he will make them clear cut and correspondingly larger. He will not, however, make an unimportant detail so prominent as to attract to itself the attention which should be bestowed upon the main structure. Most important of all, he will avoid excessive ornamentation, or poor ornamentation.

It is necessary now to hurry over a number of elements important in aesthetics, but relatively unimportant in engineering design.

COLOR.—The use of color in engineering is so limited that discussion is hardly worth while. Materials such as stone, cement, and brick, are usually of a neutral tint and harmonize with natural surroundings. They suggest the colors suitable for use in painting steel structures.

CONTRAST.*—Contrast, called by Mr. Herbert Spencer an *essential* requisite to all beauty, can be and often is used by the engineer. Different kinds of stone, or stone and brick, are common examples of contrast in materials and colors, not to mention contrast in forms or outlines. Strong contrast, however, though it may be momentarily pleasant, may soon become tiresome, and hence must be used with caution. *Vividness of Impression*, though often a source of aesthetic delight, should, in engineering, stand for that which is clear cut rather than for that which is startling. *Harmony*, another aesthetic element, stands not only for the harmony of different parts of a structure with each other, but for the relation of the structure as a whole to its surroundings. The parallel chord bridge truss, with its system of triangles, is ugly for more than one reason, but in certain locations, it offends chiefly because it is not in harmony with its natural surroundings. Nature abhors a triangle except possibly in crystals and other small objects. *Imitation* of nature may not be the method of true art as Aristotle held, it may even be impossible in most engineering work, but it is well to have a structure on speaking terms with nature.

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* Contrast "involves the action of organs, which through mere rest have become well prepared for activity, and which therefore produce pleasurable activity when stimulated." *Pain, Pleasure and Aesthetics*, Marshall.

Man is so accustomed to nature's methods that the work of his own hands offends because it seems artificial, that is, unnatural. As an example of this Marshall writes:

> "All of nature's lines are affected by the power of gravitation. It seems clear to me that the relative grace of the suspension bridge and of the cantilever truss is principally determined by the fact that the catenary curve in the one case presents nature's pendant form, while the strutted extensions of the cantilever bring to us other lines than those with which she has educated us."

Mr. Van Brunt writes in *De Pontibus:*

> "The modern steel girder or cantilever bridge, while, according to our present knowledge, it is perfectly adapted to its uses and functions, is in nearly every case an offense to the landscape in which it occurs. Its lines, since they have ceased to be structural curves, have become hard and ascetic mathematical expressions, and have not been brought into any sympathy whatever with the natural lines of the stream which it crosses, of the opposite banks which it connects, of the meadows, forests, and mountains among which it is placed. All sylvan effects of harmony are shocked by its discordant intrusion."

This is true, but on the other hand as one becomes familiar with an unnatural object he becomes more used to it, that is, it becomes more and more natural until, perhaps, it ceases to be painful and may become pleasureable. This suggests the element of

ASSOCIATION.—There is a school of writers on aesthetics, of whom Alison was an example, to which this element of Association seems to be the basis of beauty, and hence beauty a matter of taste. This much at least is true, that individual standards of beauty are without doubt influenced by association. For example, a civil engineer may look for beauty in the permanent *stability* of a structure, while the mechanical engineer may see it in the rhythmic *motion* of a machine. The architect finds beauty in massing and proportion; the sculptor in form, light and shade, expression; the painter in composition, color, idea. Thus through all the arts—and among people everywhere, the principle of association is at work and individual taste is largely governed by it. The values of such elements as utility, stability, symmetry and proportion spring more or less from association. The principle of association is a valuable check to the craze for novelty, and compels the new in art to win its way if it is to be permanent. Subtle as is this element, it must be reckoned with in all aesthetic design.

TRUTH.—Some writers on art have also emphasized the element of *truth*. This element finds its extreme illustration, perhaps, in certain Greek sculpture, where the back of a statue was as carefully carved as the front, although the back, placed against a temple wall, was never intended to be seen. On the other hand, the triglyph in Greek architecture may be cited as an example of untruth. These triglyphs correspond to the ends of ceiling beams in primitive wooden construction, but being of stone cannot really be the projecting ends of beams. This is so evident that they deceive no one, nor were they intended to deceive, but they were retained because they added beauty to the whole frieze. Surely such untruth as this is justifiable. The white lie is harmless when so perfectly apparent. There is, however, a difference between untruths never intended to deceive and actual deceit.

Ruskin earnestly protests against the *latter* in his *Lamp of Truth*. He broadly groups architectural deceits under three heads.

(1) The suggestion of a mode of structure or support other than the true one.

(2) The painting of surfaces to represent some other material than that of which they actually consist (as in marbling wood), or the deceptive representation of sculptured ornament upon them.

(3) The use of cast or machine ornaments of any kind.

Mr. Van Brunt writes in *De Pontibus* (p. 42):

> "The architect will not find it difficult to agree with his brother the engineer, that a mask of ornamental cast iron, covering the essential features of a structure in order to force upon it an effect of grace, is illogical in the extreme."

On the other hand, it is sometimes best to cover up the skeleton of a structure, as Mr. Russell Sturgis points out in a paper read before the Society for Promotion of Engineering Education (on "Aesthetics in Designing"). He says in speaking of a certain kind of work:

> "Moreover, the engineer has to build on time, to build and to plan also and to calculate and decide, working always under a time penalty. Working so, planning so, he has only one way open to him as far as I can see—

he has to build a structural shell or skeleton, mass or framework, and then to cover it up with terra cotta and sheet metal, covering brickwork, without with fine stucco; tiling and marble slabs within. There is a school of design in that, and one based upon the traditions, too, if we understood the traditions aright."

Also we read in *Sense of Beauty:*

> "We learn to value truth more and more as our love and knowledge of nature increase. But fidelity is a merit only because it is in this way a factor in our pleasure. It stands on a level with all other ingredients of effect. When a man raises it to a solitary preeminence and becomes incapable of appreciating else, he betrays the decay of aesthetic capacity. The scientific habit in him inhibits the artistic."

In conclusion then, it would seem that the engineer should avoid all sham, deceits and downright lies in designing, but that, on the other hand, truth is but one of many elements of design, and to these elements it may be properly subordinated, when by so doing the beauty of the design is undoubtedly enhanced.*

SHOCK.—When we are told that the avoidance of *shock* is necessary to aesthetic impression, we are given a more important and helpful rule than at first appears. It is true that not all shock is painful, indeed pleasant shock, "if caused by the emphatic emergence of an interesting object, gives the effect of the picturesque, but when it comes with no compensation it gives us the feeling of ugliness and imperfection."† In the lack of symmetry, of utility, of the appearance of stability, it is the shock of not seeing what from association we feel that we *ought* to see, that offends our sense of beauty. Schiller wrote "beauty can tolerate nothing abrupt or violent," which, perhaps, sums up the whole matter.

EXCESSES.—Shocks most often result from excesses and it is here that Aristotle's great principle of means between extremes is well illustrated in the phenomena of the beautiful. Excesses lack the element of permanence and for this reason, if for no other, should be avoided in designing.

SURPRISE and NOVELTY are often pleasurable shocks. The pun and other forms of wit depend upon pleasurable surprise.

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* See article on "Truth" in *Dictionary of Architecture and Building* for a more elaborate discussion.

† *Pain, Pleasure and Aesthetics*, p. 141.

but if repeated become painful. "Note in this connection," writes Marshall, "the tiresomeness of all artistic products which depend upon startling effects, and the relief which we feel when we turn to the contemplation of those works which deal with the calmer effects of unity." (P. 297.)

ORIGINALITY.—Novelty suggests originality. Just now there is a great demand for *original* work, by which is too often meant *new* work. As Prof. Hamlin of Columbia University recently pointed out in a Yale lecture on "Originality in Architecture and Other Arts of Design," "innovation is not originality." Yet so strong a hold has the idea that originality is found in novelty that it is almost impossible to resist the demand for that kind of work. In our universities much of the so-called original research is merely *new* work of no value. In architecture the most ignorant architects are those who in their design disregard the teaching of the history of architecture. When the craze for novelty subsides, the artistic level of architecture and the other fine arts will rise. Experiment is valuable when it is intelligent, and intelligence presupposes a knowledge of what has been done before. True genius sometimes implies invention or creation of something new, but more often it is the power or capacity to surpass the achievements of others, not by disregarding the results of their work, but by using them. Says Emerson, "We owe to genius always the same debt, of lifting the curtain from the common, and showing us that divinities are sitting disguised in the seeming gang of gypsies and peddlers." (Works and Days.)

The reason that we must search the history of art is to find elements of beauty which are permanent, that is those qualities which please and continue to please while generations come and go.

PERMANENCY.—Permanency then is closely related to aesthetics. Marshall differentiates aesthetic pleasures from pleasures in general, on the basis that "aesthetic pleasures are relatively permanent in revival, while pleasures which are non-aesthetic are really, at the moment of judgment, only pleasures in name." (P. 347.)

This explains the so-called "fad." Fads in music, painting, architecture or designing may please for awhile, but the pleasure becomes less and less in revival, until the fad is dropped. The popular song pleases at first but, to use the common expression, we soon become "sick of it," and it is noticed that once such a song has had its run, it is seldom revived. The popular sales of a book is no criterion of its value as an art product for the same reason. These things lack permanence. But Beethoven and Mozart in music, Raphael and Titian in painting, Homer and Shakespeare in literature are among names which suggest permanence. The *permanence* of the teachings of Christ through the ever changing conditions under which men live is evidence of the authority of those teachings. These illustration are intended to show the value of permanency. But time, and a very long time, is needed to determine *what is* permanent. The experiment must extend over centuries. Hence men search history to find, if they can, what elements in art are permanent. "Ancient work," writes W. R. Lethaby, "should be properly used as a body of ready-made experiment and as a glass for self-criticism."

But shall we venture on nothing new? Shall we not progress? Yes, but to quote Dr. T. T. Munger, "Progress is not a blind rushing into the future; nor is it living in the light of the present alone. Progress consists in carrying all that is good in the past along with us into the future." Not that progress lies in the repetition of the past, but in the *addition* to whatever the past has handed down.

Engineering in these days has to do with much that is new. Progress is in the air and men are busy everywhere with experiments. In striving for aesthetic results in engineering design it is well to remember that although the *type* of structure may be *new* the *principles* of aesthetics are very *old*.

From the past we get authority and to it we must add reason. To again quote Mr. Lethaby: "All criticism of art which is not a mere expression of 'taste' comes to this: it is either a statement of authority, or it examines a work 'according to reason.'"

PRELIMINARY DRAWINGS.—Too much dependence upon preliminary drawings has, in the past, led to serious mistakes, and too often a design which looked well on paper has been disappointing when carried to completion. There are two reasons for this: (1) The preliminary drawings, as well as the working drawings in engineering, are usually made in orthographic projection (plan and elevation), and in this flat projection the elevation can never represent the structure as it will appear to the eye; indeed it often will give an entirely false impression of it. The remedy for this lies in the more general use of linear perspective, and where aesthetic results are important, the extra time required in making perspective drawings, in addition to the usual orthographic projections, will be well spent. This is done in important architectural work, it must be done also in engineering design.

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* *Dictionary*, etc., p. 774.

(2) A second reason for disappointment is found in the tendency to ignore natural surroundings. The preliminary drawing gives a clear view of the structure from end to end, well defined against the paper, and standing by itself with no adjacent structures to raise the questions of harmony; in reality it may be partly hidden by its surroundings, not defined at all against the sky or other even background, and out of all harmony with nature or with adjacent structures, if there be any. On paper it is seen from end to end, in reality it may be too long to be seen from any one point of view. On paper, perhaps, a side view is shown, when in reality it will always be seen from one end or from above. The remedy is obvious but hard to apply. It is to bear in mind the point of view from which the structure is to be seen, what portions are likely to be obscured, how other portions will appear in perspective, with what as a whole it must harmonize, and then in making the preliminary drawing design accordingly.

Some may recall, perhaps, a striking illustration of how preliminary drawings can mislead even engineers of unquestioned ability. A design of an important bridge of unusual length was recently rejected, in spite of its great merit, because it appeared *on paper* to be less symmetrical and more poorly proportioned than another, otherwise inferior, design submitted in competition. In this case the bridge crossed a deep gorge in such a way that from no point of view could the structure be seen as a whole; indeed only a comparatively small portion of it could be seen from any point of view.

The site of a structure may often be improved at slight expense. A little earth removed or filled in, a rock cut down, a few trees added or taken away, may serve to reveal completely the beautiful lines of a structure, or to harmonize its otherwise discordant features. (See Luxemburg Bridge Engineering News, March 6, 1902.)

THE ECONOMICAL AND THE BEAUTIFUL.—In engineering, at least, no discussion of aesthetics ought to omit or evade the question of cost. It must be admitted that competition on the one hand, and insufficient appropriations on the other, often prevent the engineer from gratifying his own taste in designing. Too often it is all he can do to secure utility, strength and durability, without exceeding the cost limit. But even in such cases there is still some freedom left in which to avoid glaring aesthetic defects even though positive beauty may not be attained. A design negatively aesthetic is better than one positively ugly.

There is comfort also in the thought that if history repeats itself it will not be long before the American people will be glad to pay for beauty. The young nation has been busy in providing for its physical wants, and in amassing wealth. It has already begun, however, to turn its attention to the less imperative needs, of which beauty is one, for, as some one has said, "man is not only beauty-loving, he is beauty-hungry." Prosperity not only enables a nation to gratify its craving for beauty, but it encourages and pays for *experiment in art* as in other things. Hence, prosperous epochs in a nation's life, although seemingly accompanied by corresponding periods in art of experiment and chaos, have almost invariably resulted in a distinct and often very great aesthetic gain for the whole people.

There is another line of thought, however, which seems to have been but little developed. It is that *in engineering design* [illegible] Emerson held that the [illegible] become the beautiful, and Herbert Spencer seems to agree [illegible]. This may be because in the evolution of things [illegible] survives, partly because man is constantly [illegible] eliminating the ugly, and partly because of association [illegible] become beautiful to us. But after [illegible] the truly economical is also the truly beautiful [illegible] seem as if a God-given force were at work [illegible] the result of evolution the results of man's labor into harmony with the work of the Creator.

Mr. Henry Van Brunt, in *De Pontibus*, comes very near to this thought when he writes,

> "Now it seems to me important to note that the methods of nature always culminate in infinite expressions of beauty, and that beauty is an essential part of the principles of natural growth. The Great Creator never makes anything, animate or inanimate, ugly in making it strong or swift or durable, or in fitting it to the economy of nature. Grace is a part of the system of creation. Is it reserved for man in his secondary creation to make things unlovely in proportion to their complete and perfect adaptation to the satisfaction of his practical needs? Is this difference significant of some quality which is wanting in our science?"

This is a striking thought suggested by Mr. Van Brunt. Dare we carry it further? Dare we make beauty the criterion of fitness and true economy? To say that the truly suitable and economical must also be the truly beautiful is to make a statement which cannot be proved, but which is interesting as a speculative thought. Is it true that all that is ugly in our engineering structures is so because (1) either the structure itself is in process of development or (2), because it is unsuited to the ultimate needs of men and will sometime be replaced by a different type. That this thought is not wholly without reason is easily shown, and it seems possible to point out the tendency of the suitable and economical to become beautiful. For example, in Mechanical Engineering it must be admitted that machinery in general has developed along the line of beauty as well as efficiency. The locomotive has become a thing of awful beauty, and the same is true of most stationary machines. Compare the bicycle of to-day with the old high wheel of a decade ago. The faster the modern yacht, the more beautiful its lines. The transition curve or spiral curve, and the gentle vertical curve were adopted to avoid shock, and consequently wear and tear on passengers and on railway equipment, but they also eliminate the abruptness which is detrimental to beauty. The beautiful curve to the apron of a dam is theoretically an economical one. Everywhere the curve is at work to eliminate shock or abruptness, no less fatal to beauty than to the life of stone and steel. The city pavement is not only useful and economical but pleasing to the eye. It is no longer thought necessary to dig ugly ditches "for drainage," or give excessive crown in country roads. Economy of road construction is teaching us better and at the same time eliminating the ugly. The work of the sanitary engineer in cleaning and purifying the surroundings of man for hygienic reasons (which are also economic reasons), at the same time beautify those surroundings. The railway companies will realize that it is cheaper to keep tunnels free from smoke than not to keep them free from collisions, and so tunnels will become less ugly and disagreeable. Ruskin thinks that "no Venetian, or Italian, or Frenchman, or Englishman is likely to know or care more, whether any God-given cloud is white or red; the primal effort of his entire existence being now to vomit out the biggest black one he can pollute the heavens with;" but that too, in the economy of things, will pass away and the people of our cities will enjoy the true beauty of the sky.

Gas and electricity on our streets are cheaper than crime and accident, and so our cities have become beautiful by night. Railways find it a good business proposition to make stations and equipment aesthetically attractive. The same is true of great stores, theaters, hotels and other places for public use. Even whole cities are coming to realize that it is good economy to spend money in making themselves *attractive* abiding places. World's fairs and expositions, though in themselves usually financial failures, are, commercially and otherwise, good investments, and act at the same time as powerful agents to diffuse a truer sense of beauty throughout all nations. Thus it is that in *economy* beauty finds a powerful ally.

But, it may be urged, there are some things in engineering design that are apparently best adapted for their purpose, and yet seem inherently ugly: structures, for example, which no amount of elimination of the ugly can ever make beautiful. True, but is it not possible that these structures themselves are to be eliminated? The "hump" in a swing bridge has evaded all attempts to beautify it, although its ugliness may be somewhat softened, but the *hump* is *essential* to the swing bridge. Yes! but is the swing bridge itself essential? Dare we say that it will not be sooner or later displaced by the roller lift or by some other form which will be at the same time more economical and more beautiful? The ugly cantilever is giving way to the suspension bridge and the arch,—if it is ugly beyond repair it may disappear entirely. The homely plate girder in our parks is being replaced by the stone or cement arch, and the Melan arch already threatens to equal it in cheapness, while far surpassing it in beauty.* We are learning that the economical and best way of laying out a city is not in blocks uncompromisingly rectangular, but in blocks traversed at intervals by diagonals, the intersections of which form squares and parks, and these add beauty to the city.

Underground conduits, because on the whole they save money, are being used in our cities in place of unsightly wires and poles. Wireless telegraphy, when perfected, the storage battery, compressed air or other form of motors, may still further remove telegraph poles, trolley poles and wires everywhere. In our large cities, subways will probably replace elevated roads and, to some extent, surface lines, while the horse will give way to the automobile, and so our streets will be still more cleanly and attractive. More effective and economical means of advertising will gradually eliminate the bill-boards and signs which mar the landscape. Thus, gradually, unaesthetic features, which seem necessary to our present civilization, may become eliminated. These illustrations have been given, not to prove a theory, which from its nature cannot be proved, but to suggest a line of thought. For the present engineers can at least say this: If our design has its ugly features, we should seek to eliminate them, or to replace them by something more pleasing, before excusing the design on the ground of economy. If, however, a thing is inherently ugly, it *may* be a hint to us that we are on the wrong track altogether, and probably some entirely different type is just as suitable or economical, and more beautiful.

A brief summary of this paper may be given as follows:

1. The increased demand for aesthetic results in engineering design will both enable and compel the engineer to pay more attention to aesthetics.

2. Aesthetics can furnish the engineer with no fixed rules or standards of taste, but it can suggest certain lines along which aesthetic development must take place.

3. Some of these lines are suggested by Utility, Stability, Proportion, Symmetry, Grace, Massiveness, Simplicity, Unity,

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* The author would not be understood as believing that beauty can only be attained by replacing the steel bridge by the stone bridge.

Form, Structural Form, Details, Decoration, Color, Contrast, Vividness of Impression, Harmony, Imitation, Association, Truth, Avoidance of Shock, Novelty, Originality, Permanency, Preliminary Drawings, and Economy.

The sense of beauty, like all culture, is subject to growth, and growth requires *time*. It may be hastened by right conditions, an important one of which is *light*. It pays to read, for example, John Ruskin, though one may not agree with him in much that he writes, for the man that awakened all England from lethargy in matters of art ought at least to stimulate the individual to seek light. The study of architecture is another fruitful source of inspiration. And so, busy as he is, the engineer can shape his reading, and so maintain a receptive attitude of mind, as to develop that true sense of beauty which, after all, is necessary to aesthetic design.

There lived in the fifteenth century a man by the name of Albrecht Dürer. He was perhaps the first artist in Europe to study nature carefully for its own sake, and with a view to making it a subject of art, and among other things this is what he wrote:

> "Beauty dependeth on many things. When we wish to bring it into our work we find it very hard. We must gather it together from far and wide.... Out of many beautiful things something good may be extracted, even as honey is gathered from many flowers. The true mean lieth between too much and too little.... I apply to what is to be called beautiful the same touchstone as that by which I decide what is right.... No man living can grasp the whole beauty of the meanest living creature.... We find in Nature a Beauty so far surpassing our understanding that not one of us can fully bring it into his work."

Five centuries later we find men still of the same mind, and in a recent editorial in the *Outlook* we read:

"God made the world beautiful: man in his ignorance has made it in many places repulsively ugly; man in his wisdom must undo the work of his ignorance and make the world, so far as he has anything to do with it, beautiful."

THE PRESIDENT: If there is no discussion I would like to call upon Mr. Bond.

THE METRIC SYSTEM AND ITS PRACTICAL APPLICATION, AS COMPARED WITH ENGLISH UNITS FOR LINEAR MEASUREMENT AND THEIR SUBDIVISION.

By George M. Bond, M.E.

Mr. President and Gentlemen of the Connecticut Society of Civil Engineers:

It is with considerable diffidence that I have accepted your President's invitation to say a few words upon the comparison of the subdivisions of the English and metric systems, and which applies more particularly to linear measurement, this having been my life-work, or practically so, for nearly twenty-five years. I appreciate fully the honor of having an opportunity so favorable to present to you a few facts for your consideration, which I have noted from my own experience and from the experience of others.

It may not be necessary to say much in regard to the history of the metric system, or how it was originated. We all know more or less of the causes which brought it about, and why it was urged upon the French nation and other Continental countries, by compulsory legislation. It was in France a desire, following the period of the Revolution, to change the existing state of things, not only political and economical, but also to do away with everything connected with the old régime and even, as a matter of fact, to do away with the old established subdivisions of time.

Still the elements of the metric system were not original with the commission which was appointed at that time, as may be supposed by many, for over one hundred years previous Gabriel Mouton, a modest and humble choir master and priest of the church of St. Paul of Lyons, evolved a scheme which practically was the original idea embodied in what is now known as the metric system, although he gave it a different name, and his units were somewhat different.

The system of Gabriel Mouton, the priest, was started with one of the old French subdivisions, in 1670, using the unit which he called the "millesima," equal, practically, to seven-thousandths of an English inch. He then multiplied it by ten, giving the centesima, and by a little variation, owing to a slight difference in size, to compromise matters no doubt, he obtained by multiplying by ten a virgula, which was equal to 7.290 inches. This multiplied by ten produced the virga or rod, and was equal to exactly six feet, showing that at that time it was necessary to adopt certain well known units with which the people were familiar. This multiplied by ten gave the decuria, or cable, which was equal to 61 feet. Allowing for a little variation, the next unit was the centuria, or furlong, equal to 608 feet. Then by further multiplying by ten, he obtained the milliar, or nautical mile, which, curiously enough, is the nautical mile recognized to-day, and is correct within .26 of a foot.

This priest showed wonderful originality in other ways, for he also experimented with the pendulum for establishing the exact length of the standard, and conducted a great many interesting experiments to determine this, which were highly creditable to him, in view of the limited facilities he had at his command at that time for carrying on such work.

This was really the starting point for the metric system. It was, and now is, a system of decimals, or the use of the multiple of tens, and which seemed at the time to be the proper way of securing the various units employed. But, as I want to show at this time, the metric system is not well adapted in its subdivision by tenths to the ordinary needs and work of the common people, or for use in ordinary practice.

It is, however, well adapted, as we all know and appreciate, for most all scientific computations, and for mathematical discussions, and for chemical laboratory work, as the nomenclature of the latter is practically universally accepted in the metric system. Perhaps if there were employed two more digits we could use two more decimals with even better results and more convenience than is even now claimed by the advocates of the metric system. There has been an argument advanced, or it has been proposed that we have an international system, so that all nations of the earth would use the same weights and measures. This might be very convenient for some, especially from a commercial point of view, but it might just as well include an international language. It would be exceedingly convenient to have all nations speaking in the same tongue, but this is hardly a possibility. People cannot all be equally good or all equally poor. People will continue to use what is most convenient for them, whether it be their language or their system of weights and measures, unless, as was the case in Europe, they were compelled to adopt a system which did practically unify their weights and measures, not having a uniformity of any kind. Especially so in the case of the consolidation of the German Empire. There they had worried under the disadvantage of having nearly seventeen different lengths of a foot.

The metric system, as we all know, was legalized by act of Congress in 1866, as an *optional* system for weights and measures, and since that time, and even long before, there has been a determined effort maintained by scientific people to have it made compulsory in its general use.

The practical application of this, evidently, does not appeal to those who are practically concerned, and the majority of every-day people, manufacturers, engineers, architects, mechanics, and all who are compelled to use the simplest and most convenient units to express the idea of length, or dimension, or weight, fail to adopt the metric system in spite of the many arguments in its favor presented by the scientific advocates of it.

Primarily, its unit is the metre, and the system based upon the subdivisions and multiples of the metre. Measures of weight and volume are, as is well known, a definite relation in metric terms, and all this referred to distilled water as its ultimate basis. The great difficulty in its use for practical purposes is that, while convenient in many ways for calculation, it is not convenient for mental operations, and thus does not appeal to people who have to think and act quickly, without continually referring to pencil and paper or to long rows of figures which cannot possibly be remembered with any degree of readiness. The units are also not as convenient as those of the English system, for the latter has a name for many of the different sizes, which are used for their special purpose, and are thus much more easily remembered and quickly comprehended. This is why the metric system is not adapted for the business of everyday life, whatever the advocates of the metric system may argue to the contrary. In the English system, while it has a great many abnormal outgrowths, as you are well aware, in the way of terms that are now obsolete, the subdivision of the yard, which we call our standard, into three parts, is certainly a practical convenience.

People can divide anything into three parts, and can have each part, even by guessing, nearly correct, while the more important subdivisions come when we divide by halves. This binary method of division is one of the practical advantages of this everyday system, and one which the common people, who have to deal with these things more than anyone else, in fact continually, can readily see. The foot is subdivided, as we know, into twelve inches, and these into smaller subdivisions. The inch is halved, quartered, divided into thirds, and after being quartered, is again divided, and further into sixteenths, which is the ordinary finest unit for the carpenter, and then into thirty-seconds, or even sixty-fourths. For those who need finer dimensions, better measuring instruments are used, and these are in everyday service in the tool room and machine shops of to-day, and read to thousandths and even to one-ten-thousandth of an inch.

The trouble experienced in using the metric system in ordinary work is its want of adaptability for expressing to the ordinary mind, or in fact to any mind, a quantity that can be readily grasped by a single mental operation. It is not adapted for giving a clear perception of dimensions without going through some mental calculation which has to deal with multiples of a small unit, or with decimals, or by some abstract conception of what a decimal means. If we should say, in the English system, that a man is five feet seven and one-quarter inches tall—easily absorbed by the ordinary mind, being a gradual addition of well defined units—it makes an impression that is readily understood and grasped. But it would be difficult to express this so clearly in the metric system because one cannot use a combination of units so as to have it readily comprehended without a more extensive mental effort. Expressing it in the metric system takes quite a little stretch of the imagination to absorb it all at once. One might say the man was 1,776 millimetres tall, and at first glance at the figures call him a remarkable man. He would simply be 1,776 millimetres tall, or, expressing it decimally, using the same number of figures (there is no alternative), call him 1.776 metres tall. The intervening divisions of the metre—the decimetre and the centimetre—are not so much used as units, so that if one connected the fact of his height with the date of the Declaration of Independence, the fact might thus be better remembered. As Dr. Sellers has so forcibly stated it, if a pane of glass is to be replaced, the ordinary 8 by 10 size becomes in the metric system a matter of using more figures, as its equivalent is practically 228 by 258 millimetres, and probably hard to get, at that. The increased number of figures required to express even an ordinary dimension, as that of a small pane of glass, is only one of countless instances of the lack of simplicity with which such things are expressed in the metric system. The English system was evolved through a long experience of a common people, and embodies utility and an economy of time, which can hardly be said of the other, outside of its use for computation.

As Dr. Sellers also expresses it, if the good woman of the house presents her husband with a baby, by the usual method of weighing it might be a ten pound boy, easily understood and a source of congratulation to all concerned, but if expressed in the French system it would not sound half as vigorous at 4½ kilos; in fact, it might be a source of disappointment instead. As a matter of fact, the kilo is too large a unit for everyday use, and when one thinks of it, the size and weight of nearly everything that is made and sold and used is marketed at retail, and its rate computed mentally by the common people, who do all this retail buying much more readily on account of the convenience of these units; it would, consequently, be hard to adjust themselves to the use of a system based on units too large for their purpose, or which must be divided by tenths to get the next tabulated unit. In Paris, as I have noticed personally, people buy by the half kilo, thus getting nearly the English pound for the unit. This is even quartered, thus securing for their use a quantity more nearly equal to their wants. A tenth is too small, and besides the quantity would look insignificant, if so divided. Thus even in Paris, the natural method of halving and quartering the unit called a kilo brings it into a size by subdivision better adapted to and preferred by the mass of the common people, for it thus more nearly meets their wants.

Dr. Sellers tells of a curious incident happening in Germany at the time of transition to the metric system after it had been made a compulsory measure by law: A gentleman going to market asked for a pound of butter. The shop man told him "You mustn't say that, you must say kilo." "Well," responded the buyer, "give me a pound of kilos, I don't care what you call it." He knew what a pound was and would stick to it.

Some writers have claimed that it is so much easier to make computations in the metric system, but if one considers the great mass of books of reference for engineers that are now available, I think it would be interesting to note the great number that include the English units, tables of every kind being given in feet and inches, and weights in pounds.

Comparatively few are given in the metric system, and as the results of experiments by the best engineers of the world on strength of materials are in English, the units of this system are used exclusively. In fact the expressions are so much more simple and thus more easily comprehended, than if long rows of figures, such as is necessary under the metric, are used. Take, for example, Hodgkinson's tables for calculating the resistance of beams or of materials, his experiments being all based on terms of size of specimen 1 inch by 2 inches. These tables are classic, and if they are to be transposed into metric, it requires four figures, four decimals at that, for each of the simple terms above given. To illustrate this, the diameter would be .0254mm., and the length .0508mm. if in terms of the metre as the unit, or if the millimetre is used, then we should have 25.4mm. by 50.8mm., as the result of the new expression in place of the simple 1 inch by 2 inches. There is no comparison whatever in favor of the metric system in this respect.

In the metric system it is customary to say the pressure of one atmosphere equals one kilo per square centimetre, while in the English system it is stated as 15 pounds per square inch. The latter fully as easy to remember and nearer correct.

Wrought iron or steel bars with parallel sides are equal to one-tenth of their weight in pounds per square yard. Thus having the length of such shapes in yards we have the sectional area, and it is easy to remember that a weight of 80 lbs. per yard for a safe load of 10,000 lbs. per square inch, with 8 inches sectional area, can safely be loaded with 80,000 lbs. There is thus a relation between the section and the strength under the units of the English system, which the advocates of the metric system fail to recognize. Drawings made to scale at once exhibit the simplicity of the English system, making it convenient to use ratios or proportions in great variety not possible under the metric system. We have by consecutive halving these convenient subdivisions in size; we also have the convenient ratios of ½, ¼, ⅛, $^1/_{16}$ inch per foot, or, if we like, ⅓ inch per foot, ⅔ inch, ¾ inch, or 1 inch per foot. ⅓ scale is 4 inches, and ⅔ is 8 inches per foot. Under the metric system but few convenient ratios are possible, and these, besides introducing decimals in the dimensions, are liable to the error due to the wrong position of the decimal point. If the millimetre is used as a unit, it requires more figures to express a simple dimension than by the English units, and if the metre is employed, and dimensions less than or more than one metre, necessitates the use of the decimal point.

In using the cubic inch, the cubic foot or yard, we employ the unit most convenient for the purpose. This depends upon the character and size of the work, and, as Dr. Sellers so aptly states it, a person does not use a tack hammer for driving a railroad spike. Hence, by the use of the various English units, we obtain what is needed on a scale that is most readily comprehended by those who have to do the work which the drawings or specifications represent.

The railroad interests of the country, a most important part of the practical application of the units, both for linear and for measurement of weight, would find it a great inconvenience if required to abandon all this well tried and simple system for expressing the many details of design and construction, besides the element of repairs, and it would be impossible to estimate the effect of compulsory legislation, making the changes in view under the metric system, in the dimensions of drawings, and standardized details which now mean so much in the construction of cars and the equipment for railroads. This matter was, as you probably know, agitated some years ago, in 1889, but the Committee appointed to consider it and to report to the Master Car Builders' Association as to the advisability of adopting the metric system for such use, did not recommend it. At the time, I had the honor of expressing my views upon the subject, and Dr. Sellers also wrote a letter, appearing in the April issue of the *Master Car Builders' Journal,* New York, which had the effect of placing before the railroad people facts which were no doubt convincing, in opposition to the adaptability for their service of the metric system.

Railroad people are quick to appreciate and to adopt methods, or, in fact, anything of advantage to them to simplify their work, and if the advantages so strongly urged by metric advocates had appealed to them, their recommendations would long ago have been adopted. The reverse is quite apparent.

The late Mr. Tatham, a manufacturer of shot, in lower New York City, was greatly interested in the metric system, as a scientific man, which he was as well as a manufacturer, and being a member of the Franklin Institute of Philadelphia, was one of the committee appointed by the Institute to report upon the adaptability of the metric system for common use. He stated in 1876 that "the advantages of the metric system, if adopted, would be less than the damage resulting from it during the transition from one to the other, and even considering the advantage which it might be afterwards, he said it would increase the cost of production and not diminish it." This opinion is confirmed by the experience of William Sellers & Co., of Philadelphia, as often stated by Dr. Coleman Sellers, who as an engineer and a member of the firm had ample opportunity for observation, and has as often given logical reasons for statements in opposition to the metric system as an economical or convenient one for everyday use. As Dr. Sellers was one of the most active advocates of the optional use of the metric system, being largely through his efforts that the act of Congress in 1866 legalizing it for the use of the people of this country was passed, his experience certainly should have much weight, and evidently has had in the past, for he first found its deficiencies by giving it a fair trial in his own works, with every advantage claimed for it given a chance to prove its value.

One department of the works was fitted up in the metric system, in order to take up the manufacture of the Giffard injector, a French invention, and thus, necessarily, originally made throughout under the metric system. Drawings, tools, gauges and special fixtures for the work were all metric, and men were trained especially to use them. But after over [illegible] years experience under every condition possible to favor it, it has been found to confirm the opinion of Mr. Tatham, to which

I have just referred, and is to-day a practical example of the fallacy of the arguments so often urged by the advocates of the system, that it is an economical and convenient system for manufacturers to adopt.

There is even a question about the absolute value of the metric system for computation as applied to time and the circle. It is interesting to note that at the time of the adoption and enforcement of the metric system in France, under the recommendation of the Commission, the division of time was undertaken decimally, but an obstacle was encountered very difficult to overcome. They adopted the second as the smaller unit, with one hundred seconds for a minute, one hundred minutes for an hour, ten hours for a day, ten days for a week, making thus but one day in ten for rest, and thirty days for a month, which obviously could not well be altered under lunar conditions, not easily changed. They were obliged to accept twelve months for a year, but at that had five days left over, calling these "sans culottes," or days without breeches, given up to fun and frolic, in an attempt, probably, to atone for the few days of rest on the lengthened weekly basis. They struck another "snag" when the circle was divided decimally, attempting to ignore the old Chaldean system of dividing it into 360 parts. We all appreciate the advantage of this subdivision, giving a far greater facility for expressing the natural and most convenient divisions, with 90 degrees for the quadrant, and numberless other advantages which need no argument to prove. It was afterwards recommended that the circle be divided into 400 parts, but this was objected to by navigators, unless they could have 400 days in a year, as one old captain insisted, if 400 divisions were to be adopted. This naturally failed to be accepted even by scientific people, for the good reason that it was not practical.

As long ago as 1821, John Quincy Adams, in his report to the Senate of the United States on the decimal question, then actively agitated for compulsory use of the people of this country, after forty years of careful investigation expressed his opinion as follows: "The decimal arithmetic is a contrivance of man for computing numbers; and not a property of time, space or matter. Nature has no partialities for the number ten, and the attempt to shackle her freedom with them will forever prove abortive."

There have been attempts at various times to compel the use of the metric system by recommended legislation, favorably reported upon by committees, but the American manufacturers, who are told of the great advantages possible by its use, do not need advice of that kind. If they find that the metric system is better adapted for their use they will naturally take it up without being compelled to do so by law. It is of course convenient for those doing a foreign business. They are at perfect liberty to use it, being already a legal standard of weights and measures. I know from my own experience in my special line of work that it is so, but I also know from my experience that it costs more to do the work in the metric system than by use of the English units, not because our men are not as familiar with it, but because it requires more figures to express relatively the same dimensions, and thus takes more time to do the work and to ascertain these otherwise simple dimensions.

We have now in process, nearly ready for delivery, a measuring machine having a graduated bar, upon which are two separate rows of plugs with polished surfaces, one row representing inches and the other row 25 millimetres, only about [illegible] inch apart, the row for inches, 0 to 48, requiring only two figures for designating each inch above 9, while for the metric row, 0 to [illegible] there are two figures above 0 and three above 99, while the last [illegible] to represent what two would easily do in the English system. [illegible] machine is for the National Physical Laboratory of England and will thus enable the operator to [illegible] system the demands of scientific work [illegible] necessary. This is only one of many illustrations of the extra [illegible] in stating ordinary linear [illegible] figures [illegible] argument to make it plain.

[illegible] English system the inch, is, as often [illegible] one for common purposes. [illegible] necessary for surveying, for [illegible] the foot and to divide this [illegible] and resulting decimals [illegible] more particularly [illegible] those who do not have the [illegible] whom fractions represent [illegible] dimensions or quantities with [illegible] regard to any inherent right of standard quality of the metre over that of the yard, neither can claim much for that, both being now respective standards by law; and so far as the inch is concerned, as stated by Sir John Herschel, its value as one five-hundred millionth of the earth's diameter is just as nearly correct as that of the metre being considered as equal to one forty-millionth of the same distance. One consideration is as valuable as the other, and just as easy to prove.

I have with me an article upon the metric system, written by Herbert Spencer, who has been referred to by Prof. Tracy in his most interesting paper just presented. I am glad to know of the wide range of subjects which has received the attention of this renowed philosopher.

He is not what might be termed a practical man, but he is one who deals with economic questions in a logical way in relation to the interests and welfare of the common people, as he also does in other matters. The article is not long and with your permission I would like to include it here. It appears in the June number of *Appleton's Popular Science Monthly*, 1896. He refers to the various systems of notation and their adaptability and says: "But now the important fact, at present ignored, and to which I draw your attention is, that it is perfectly possible to have all the facilities which a method of notation like that of decimals gives, along with all the facilities which duodecimal division gives. It needs only to introduce two additional digits for 10 and 11 to unite the advantages of both systems. The methods of calculation which now go along with the decimal system of numeration would be equally available were 12 made the basic number instead of 10. In consequence of the association of ideas established in them in early days, and perpetually repeated throughout life, nearly all people suppose that there is something natural in a method of calculation by tens, and compounding of tens. But I need hardly say that this current notion is utterly baseless. The existing system has resulted from the fact that we have five fingers on each hand. If we had had six on each, there would never have been any trouble. No man would ever have dreamt of numbering by tens, and the advantages of duodecimal division with a mode of calculation like that of decimals would have come as a matter of course."

Herbert Spencer thinks that the system of duodecimals, though it may be retarded, will finally come, and it will be a perfect system. Later on in this article he speaks of a business man's idea of this. He says: "From one who every month has to act as auditor, I have received a letter in which he says: 'I had to go over more than £20,000 of accounts yesterday, and was very thankful that it was not in francs.'"

This sounds strangely to us because our decimal currency seems so simple in comparison with that used in England, but owing to the binary feature of its scale, calculation of accounts is more readily performed mentally than is possible with a decimal system, a fact which should be kept clearly in mind in relation to the English system of weights and measures, the use of fractional subdivisions making it thus simple.

Our own decimal currency is in fact not so completely a matter of tens, for our unit of value, the dollar, is conveniently divided into halves and quarters, and the use of these terms is much more common than that of designating values as of 50 or 25 cents. The coinage of the twenty cent piece was a concession to the wishes of the advocates of the metric system at the time, to accustom people to the use of a two dimes piece, but we all know what a short life this coin has had, for no one wanted it, unless it be a collector of quaint and curious things.

Herbert Spencer then discusses this phase of the question as follows: "This statement, coming from a man of business, has suggested to me the question, by whose advice is it that the metric system of weights, measures and values is to be adopted? Is it by the advice of those who spend their lives in weighing and measuring and receiving payment for goods? Is it that the men who alone are concerned in portioning out commodities of one or another kind to customers, and who have every minute need for using this or that division or subdivision of weights or measures have demanded to use the decimal system? Far from it: I venture to say that in no case has the retail trader been consulted. There lies before me an imposing list of the countries that have followed the lead of France. It is headed Progress of the Metric System. It might fitly have been headed Progress of Bureaucratic Coercion. When, fifty years after its nominal establishment in France, the metric system was made compulsory, it was not because those who had to measure out commodities to customers wished to use it, but because the government commanded them to do so; and when it was adopted in Germany under the Bismarckian *régime*, we may be sure that the opinions of shop-keepers were not asked."

There was, however, one thing in its favor. In France, there were fifteen different lengths of the unit called a foot (*pied*), and in Germany there were about seventeen different lengths of the so-called foot, and hence it was necessary to have some system which was uniform. So no one could blame them for adopting a system which was the solution of that trouble at that time.

There is a reply to this in the next number, in July, which is very short, and yet so much to the point that I would like to read it. It is an editorial comment.

"Mr. Herbert Spencer is not one of those philosophers who think it a duty to hold severely and loftly aloof from practical and everyday questions. He is keenly interested in the daily life of the people in the widest sense of the word; and we may attribute to that fact the zeal he has recently displayed in connection with the proposition to make a radical change in the system of weights and measures now, and for many generations, established in England. Since we last referred to this subject, Mr. Spencer has addressed two further communications to the London *Times* in relation thereto. The second of these we quote entire, as being a brief, yet comprehensive statement, from the writer's standpoint, of the whole question.

To the Editor of the Times:

SIR:—Arguments and expressions of opinion may continue without end. Against those of Lord Kelvin and Dr. Stoney, I will simply set some facts already stated, joined with one other.

1. Always mankind had the decimal system at their finger ends and used it for counting. In the course of civilization they departed from it in their system of weights, measures, and values; gradually adopting instead sets of easy aliquot divisions, and especially duodecimal divisions.

2. For half a century after the metric system had been legally established, the French did not discover its convenience. The alleged discovery of its convenience went along with the discovery that they would be punished if they did not use it.

3. In the United States, where the decimal division of money is used, it has been departed from in the center of most active business, the Stock Exchange, and a system of easy aliquot divisions employed in its place.

4. The additional fact, not yet named, is sufficiently striking. The ancient wise men of the East and the modern workingmen of the West have agreed upon the importance of great divisibility in numerical groups. The Chaldean priests, to whom we owe so much, doubtless swayed in part by their astronomical arrangements, adopted the sexagesimal system of numeration, which, at the same time, facilitates in a special manner the division into aliquot parts. For 60 may be divided by 10 different numbers, 2, 3, 4, 5, 6, 10, 12, 15, 20, and 30. From this significant fact turn now to the fact presented in our ordinary foot rule. Each of its twelve inches is halved, and rehalved, giving halves, quarters and eighths. And then if we consider the subdivided foot as a whole, it gives us ten sets of aliquot parts. Beyond its 12ths, the divisions yield [illegible] inch), [illegible] inch), [illegible] inch), [illegible] inch), and [illegible] inch). And this ordinary mode of dividing the foot [illegible] experience [illegible] builders, carpenters [illegible] which best [illegible] useful set [illegible] science and [illegible] recognizing the [illegible] establish a [illegible]

[illegible] require [illegible]

[illegible] the New York [illegible] It is quite [illegible] a civil engineer [illegible]

[illegible]

[illegible] You say [illegible] decimals than [illegible] This is frequently [illegible] by no means always the case, but the foot can be and is divided decimally equally well with the metre.

In countries where the metric system obtains the unit is the metre; in England and the United States, the foot. The metre is subdivided into centimetres and millimetres, that is, into hundredths and thousandths. Although the metre is nominally the unit, I think it will be found that practically, for small measurements, it is the millimetre. Thus the practician would be more likely to say, and to write, 57 millimetres than 5.70 centimetres; or again, 178 centimetres rather than 1.78 metres. Even 1067 millimetres is sometimes used rather than 1.067 metres. The tendency will always be to use multiples of units rather than units and decimals of a unit. It is probably due to a desire to avoid that terrible source of error, the decimal point, the nightmare of all calculators, as well as for the sake of brevity in speech.

We divide the foot decimally or duodecimally, according as the one or the other division is more convenient for whatever work we have on hand. Chains and tape for railroad surveying, and even for land surveying generally, are divided into feet and tenths. Leveling rods are graduated into feet, tenths, and hundredths, and are read to thousandths of a foot by means of a vernier. For carpenters' work, and generally for all handicraft work, it is divided duodecimally into inches, and the inch again is divided either decimally, as in engineers' scales, or into eighths or multiples of eight as in the common foot rule, practical convenience in all cases governing the choice. Both systems are in actual everyday use.

Probably the two greatest practical advantages of the duodecimal system as applied to the foot, are, first, that the duodecimal subdivision has a distinct name, the inch, and therefore cannot be confounded with the unit of which it is a part. Secondly, and most important, the fact that it can be divided exactly, and without a remainder, by a great number of divisors. Thus, ⅓ and ⅔ of things are divisions of everyday use. They can be expressed exactly in the duodecimal system, for ⅓ of a foot is exactly four inches, and ⅔ exactly eight inches. On the other hand, it is impossible to express exactly ⅓ or ⅔ in the decimal system. There is no such thing as a third or two-thirds of a metre. You can no more express either in the metric system than you can square the circle.

I think the above considerations are generally lost sight of in discussions on the comparative merits of the English and metric systems. I would suggest that those who are practically interested in the matter should procure of any dealer in drawing instruments a pocket rule graduated to inches on one side, and centimetres on the other. Let them carry these around with them, and give the two sides of the rule a comparative test, and see which they find the most convenient."

That ought to settle it, I think. The inch is the real unit, and it is more convenient, in the main, to use the inch or the multiples of it. It is also very easy to subdivide it into halves, and then again by halving into quarters, and so on. So that the question of convenience, and adaptation to the requirements of ordinary everyday life would seem to be more nearly fulfilled by the English system, and it does not seem as though it was necessary to have legislation of a compulsory character in order to make people adopt what is not for their best interest, and which practically militates against their interest in certain lines, as has been so often proved by experience. It is one of the curious facts of the situation that for the most part those who advocate it are those who use it only as a means of calculation, and these are the ones most concerned to have it put in general use. A good many who are anxious to have the law passed are those who really have not considered the other and practical side of the question. It is surprising that it is so, for aside from the enormous cost which every one concerned would shrink from assuming, it would cause no end of trouble and inconvenience. As the bill is now framed or worded, it requires that from and after July 1st, 1902, all Government Departments, excepting completing the survey of public lands, shall in the transaction of all business requiring the use of weights and measures employ and use only the metric system, and by the wording of a supplemental bill, makes it, at a date fixed two years later, July 1st, 1904, the legal standard of weights and measures recognized in the United States. As the metric system, as has already been stated, is now a legal system by act of Congress, the only construction, in view of the unnecessary legislation, if intended for general use to be optional merely, is that the ultimate intention is to make its use compulsory.

I have been asked by a gentleman, who has been invited to appear before the Committee on Coinage, Weights and Measures what would be the probable cost to the age should be made. I replied that figures express it. The amount of the capital stock. referred, of the United States Steel Corporation ver it. If the bill is made a law, there will be more than observances of it, and being, under the circum- f the present legal status of the metric system a legal nless it is intended as a compulsory measure, will be so as the public use of it is concerned, unnecessary legislation.

I have had more or less correspondence for a few years back with some of the advocates of the metric system, the American Metrological Society of New York, as one instance, and I have been careful to state my position in the matter as being not opposed to the optional use of the metric system, but as strongly opposed to its compulsory adoption.

It has its advantages, and if convenient, will be generally used, but the fact that with all the advantages so persistently argued by its advocates, the people do not use nor do they want it for the ordinary operations and purposes of everyday life.

We are using both English and metric systems for the work in which I am engaged: our foreign business in gauges and measuring machines is necessarily in the metric system. We find it somewhat more inconvenient than the English system, even though our men who do this kind of work are perfectly familiar with decimal measurements, and with the increased amount of time required to designate dimensions in multiples of millimetres, the work in this system costs more to produce.

I will close by repeating, that while I am not opposed to the use of the metric system, legally optional as it is by law, as it certainly has its place, and its proper uses, I am opposed to any legislation tending to make it obligatory upon the people of this country, because it seems to me its advantages for general use are not sufficient to warrant the throwing out of what has been so long used, and because there are elements in it which make it unsuitable for the uses of everyday life.

MR. KELLOGG: I have no doubt Mr. Bond will be glad to answer any questions.

MR. GRAVES: I would like to call up one thing which I have in mind. As I understand it, the metric system and the English system are both legal in this country.

Mr. Bond: While no special legislation making the English system legal has been enacted, this being in common use, and needing none, the metric system has been made a legal standard, as an optional matter, as already stated.

Mr. Graves: And this present agitation which is going on, is in favor of making only the metric system legal?

Mr. Bond: I have here a copy of the report of the hearings in relation to a previous bill in regard to making the metric system compulsory, this having been agitated in 1897.

Mr. Graves: Where is the bill? Is it pending before the Houses of Congress now?

Mr. Bond: A new bill, with certain revisions relative to the dates on which it is intended to go into effect, is now being considered by the Committee on Coinage, Weights and Measures, to which I have already referred. The one I have here is H.R. 7251, reported favorably by the Committee of the 54th Congress. I quote from it as follows: "Be it enacted by the Senate and House of Representatives of the United States of America, in Congress assembled; That from and after the first day of July, 1898, all departments of the Government of the United States in the transaction of public business shall be required to use it." It also contains a provision, that from and after the first day of January, 1901, the metric system shall be the only legal system of weights and measures recognized in the United States. The bill now being considered changes the date of its recognition, and substitutes the word "the" for "the only legal system."

A Member: Well, is that for linear measures or all measures?

Mr. Bond: It covers all measures, linear, weight and capacity.

Mr. Graves: That is before Congress now, is it?

Mr. Bond: The Committee is now taking the evidence. There has been a hearing, at which quite a number of professional people have given testimony. They have so far only taken the evidence on that line, but soon there will be a date fixed for the hearing of representatives of manufacturing concerns. I have the honor of being invited to appear, and I presume will have a chance to say what I think about it, and as to how it will affect our business, especially as to cost. That is a point the Committee may desire to bring out.

MR. GRAVES: I don't know as it will be proper; but what would be your idea, if a Civil Engineers Society like this was to express its preference on this thing in some way? It seems to me as though it would be all right to have both systems legal, but to shut out either one of them and make the one the only legal system, and making the other illegal, it seems to me that would be a great mistake.

MR. BOND: I think if the matter was brought before the Representatives in Congress, of the different states, so that they would understand and appreciate what would be its practical application and the results, there is little danger of the bill being passed.

MR. GRAVES: I think a society similar to this one could express their ideas on the matter in the form of a resolution, or something of that sort, and it might be a good idea to do it.

MR. BOND: I should certainly have the consideration of those who represent this State.

MR. GRAVES: It's a thing that we would not want to act on hastily, but it seems to me that it would be the proper thing to do.

A MEMBER: As I understand it, now a good many foreign orders are received expressed in terms of the metric system, with the dimensions given in terms of the metric system.

MR. BOND: Oh, yes. We get a good many orders from Germany and France in the metric system, and those that come from South America are specified in the metric system in many instances.

A MEMBER: If this country is to build up a foreign commerce it seems to me we must familiarize ourselves in our shops to deal with the metric system, and it seems to me, as Mr. Bond says, if it is for the interest of our manufacturers, that will be done without any law about it anyway.

MR. BOND: If it is desirable or necessary it will come. It is one of those things in which the necessities of the case bring about a reform, if reform is needed. I think it should be left as it is, as the optional use of the metric system is already legal, and if it is the better system, it will come into general use in good time. At any rate, it will be adopted so far as is necessary for foreign business with metric countries.

MR. BUNCE: Mr. Bond's position has been rather of a surprise to me. I confess I had a wrong conception of the position he would take, and the position which he has taken here is certainly a very interesting one. I came here prepared to ask him some questions from the very standpoint that he has taken. His position has stolen lots of my thunder, and my questions are all gone into mist. I have none to ask.

A MEMBER: It doesn't seem to me that that law can ever be passed by Congress. There are no doubt advantages in the metric system, but there are so many which accrue from the use of the duodecimal system as well, that as soon as anyone is acquainted with them it is so apparent in so many ways; it doesn't seem to me public opinion would acquiesce in any such change. I doubt if they will ever pass it if it is carefully looked into.

PROF. TRACY: I think we all agree that this has been very interesting, but one feature has been particularly interesting to me chiefly because it has been suggested by Mr. Hyde, formerly of New Haven, and who read a paper before the Civil Engineers Club of Cleveland, on what he called the "Inidikil System." That paper can be obtained. He takes for his standard the inch, which is such a valuable standard to us, and builds up a decimal system on that as a base. And it seems to me that for us that system has far greater advantages than the metric system, although in some ways it has not the advantages of our ordinary system. It is open also to some of the objections which have been brought up here, and very good objections too, to the metric system.

EX-PRESIDENT KELLOGG: Now there is one thing further to come before us, which has been overlooked. We have to elect a Nominating Committee, and nominations are in order.

MR. GRAVES: I move, Mr. President, that we appoint a Committee to bring in a list of names for the Nominating Committee to be voted on.

Motion seconded and passed.

THE PRESIDENT: I will appoint the Secretary, Mr. Crandall, to bring in a list of names.

THE SECRETARY: I would propose a Nominating Committee, consisting of Mr. John C. Tracy of New Haven; Mr. Arthur W. Rice of New Britain; Mr. Norman Crawford of Hartford; Mr. L. E. Daboll of New London, and Mr. E. P. Augur of Middletown.

On motion duly seconded and passed, the above list of members were elected as a Nominating Committee.

MR. BUNCE: Mr. President, I do not think it is necessary for me to make any motion, or to propose a vote of thanks for the Committee who have so kindly arranged for the dinner which we have had. The dinner speaks for itself. I do not think we could speak in any louder terms if we should try a great many times, but I would like to propose a vote of thanks to Mr. Crawford, and the officers of the Hartford Street Railway Co., who so kindly brought us here. And I also wish to propose a vote of thanks to the two gentlemen who have given us the papers this afternoon,—to Mr. Bond, who has brought out a matter which was of great interest to all of us in so pleasant and forcible a manner, and to Mr. Tracy for his paper. And in that connection I want to say, that being one of the original members of this Association, one of its founders, I have always taken a great deal of pride in it, in its proceedings, and in its publications. I have had occasion to compare the publications of this Society with the publications of similar societies in other states, and in many instances I have been rather unpleasantly impressed with the papers that have been published in the proceedings of other societies,—not that I want to be construed as in any way making any remarks derogatory to the members of those societies, but it has seemed to me that they lacked breadth, and depth, and thought. And I wish to say that I think we, as the members of this Society, have occasion to be particularly proud of the splendid literary exhibition which we have had to-day in Mr. Tracy's paper, and in the practical worth and thoughtfulness of Mr. Bond's lecture.

MR. GRAVES: I wish to second what Mr. Bunce says. I think we ought to congratulate ourselves on the way our proceedings are broadening and growing; the scope of the papers. We ought to be proud of it.

THE PRESIDENT: Gentlemen, I take great pleasure in putting this motion, and asking those in favor to say "aye." The motion is passed.

On motion, the meeting was then declared adjourned.

List of Members.

With Addresses and Dates of Election.

Members are particularly requested to keep the Secretary constantly informed as to their correct addresses.

HONORARY MEMBERS.

PROF. RUSSELL H. CHITTENDEN ....April 20, 1901
Dean of Sheffield Scientific School, Yale University, New Haven, Conn.

JOHN E. CLARK ....April, 1884
Prof. Mathematics, Emeritus, at Sheffield Scientific School, Yale University,
New Haven, Conn.

DESMOND FITZGERALD ....Jan. 8, 1901
Engineer Sudbury Division, Metropolitan Water Board,
[illegible] Ashburton Place, Boston, Mass.

GEORGE H. FROST ....April, 1884
President Engineering News Publishing Co., New York City.

DR. ARTHUR T. HADLEY ....April 20, 1901
President Yale University, New Haven, Conn.

[illegible] ....Jan. 14, 1897
[illegible], Maine.

[illegible] ....Jan. 10, 1899
[illegible], Conn.

[illegible] ....Jan. 9, 1906
[illegible] Engineering Record, New York.

[illegible] ....Jan. 9, 1906
[illegible] Holyoke, Mass.

ACTIVE MEMBERS.

[illegible] ....Jan. [illegible]
Superintendent of Streets, Springfield, Mass.

[illegible] ....July 18, [illegible]
[illegible] Manchester and Rockville Tramway Co.,
South Manchester, Conn.

[illegible] ....Jan. [illegible]
[illegible] Hartford, Conn.

[illegible] ....Feb. [illegible]
[illegible] N. H. & H. R. R. Co.,
New Haven, Conn.

[illegible] ....Jan. [illegible]
[illegible] Bristol, Conn.

[illegible] ....April, 1884
[illegible] Middletown, Conn.

HENRY W. AYRES .... Jan. 13, 1885
Hydraulic Engineer, Hartford, Conn.

JOHN W. BACON .... Jan., 1884
Civil Engineer, Danbury, Conn.

SAMUEL E. BARNEY .... Jan. 9, 1900
Prof. Civil Engineering Sheffield Scientific School, Yale University,
New Haven, Conn.

CHARLES EDWARD BEACH .... Jan. 10, 1893
Civil Engineer, West Hartford, Conn.

CLIFFORD H. BELDEN .... March 30, 1900
Civil Engineer, Hartford, Conn.

EDGAR T. BELDEN .... Jan. 8, 1901
66 Maiden Lane, New York City.

HORACE E. BENNETT .... Jan. 8, 1901
Water Department, Hartford, Conn.

RAYMOND F. BENNETT .... March 30, 1900
W. F. Bennett & Son, Contractors, Portland, Maine.

RICHARD M. BERRIAN .... Jan. 9, 1900
Engineering Department, N. Y., N. H. & H. R. R. Co.,
Bridgeport, Conn.

GEORGE H. BISHOP .... Jan. 13, 1885
Hydraulic Engineer, Middletown, Conn.

CLARENCE BLAKESLEE .... Jan. 9, 1900
Civil Engineer and Contractor, New Haven, Conn.

GEORGE L. BLAKESLEE .... Jan. 8, 1901
Assistant Engineer Wigwam Reservoir, Waterbury, Conn.

JAMES P. BOGART .... Jan. 9, 1900
Civil Engineer, New Haven, Conn.

DANIEL E. BRADLEY .... Jan. 9, 1894
President Berlin Construction Co., Berlin, Conn.

THOMAS N. BRADSHAW .... Jan. 8, 1901
Cable Foreman S. N. E. Telephone Co., New Haven, Conn.

DANIEL E. BRINSMADE .... April 20, 1901
Secretary and Assistant Engineer Ousatonic Water Co., Shelton, Conn.

D. S. BRINSMADE .... April, 1884
Engineer Housatonic Water Power Co., Derby, Conn.

CHARLES O. BROWN .... Jan. 11, 1898
Civil Engineer and Surveyor, Danbury, Conn.

EDMUND BROWN .... Jan. 10, 1899
Superintendent and Engineer of Norfolk Water Co., Norfolk, Conn.

HENRY R. BUCK .... Jan. 10, 1899
City Engineer's Office, Hartford, Conn.

JOHN E. BUDINGTON .... March 30, 1900
Consulting Engineer and Contractor, New Haven, Conn.

CHARLES H. BUNCE .... April, 1884
Civil Engineer, Hartford, Conn.

LUTHER HAROLD BURT .... Aug. 14, 1900
Engineering Department, P. & L. E. R. R., Pittsburg, Pa.

LUTHER W. BURT .... Jan. 13, 1885
Civil Engineer and Surveyor, Hartford, Conn.

EDWARD W. BUSH .... Jan. 10, 1899
Assistant Engineer Conn. River Bridge and Highway District,
Hartford, Conn.

WILLIAM E. BUSH .... Jan. 8, 1901
Purdy & Henderson, New York, N. Y.

EMIL CHARLES BUSCHOR .... Jan. 10, 1893
Civil Engineer and Surveyor, Central Valley, New York.

WILLIAM H. CADWELL .... May 31, 1893
Civil Engineer, New Britain, Conn.

ALEXANDER CAHN .... Jan. 9, 1900
Civil Engineer, New Haven, Conn.

ROBERT A. CAIRNS .... Aug. 29, 1890
Sanitary and Hydraulic Engineer and City Engineer,
Waterbury, Conn.

HUBER D. CARD .... Oct. 24, 1895
Civil Engineer and Surveyor, Willimantic, Conn.

HARRY E. CARLISLE .... Jan. 9, 1900
Engineer S. N. E. Telephone Co., New Haven, Conn.

RALPH B. CARTER .... Jan. 14, 1890
Civil Engineer, 26 Cortlandt street, New York.

FRANK CAUM .... Aug. 14, 1900
Superintendent Hartford Street Railway, Hartford, Conn.

CHARLES F. CHASE .... March 30, 1900
Engineer Berlin Construction Co., New Britain, Conn.

CHARLES E. CHANDLER .... April, 1884
Civil Engineer, Norwich, Conn.

RICHARD OTIS CHENEY, JR. .... Jan. 9, 1900
Civil Engineer, South Manchester, Conn.

CLARENCE H. CLARK .... March 30, 1900
Draughtsman N. Y., N. H. & H. R. R., New Haven, Conn.

EDGAR CLARK .... June, 1887
Civil Engineer and Surveyor, Putnam, Conn.

HERBERT G. CLARK .... July 18, 1899
Engineer of Keney Park, Hartford, Conn.

ROSCOE N. CLARK .... July 18, 1899
Civil Engineer Department of Public Parks, Hartford, Conn.

WILLIAM S. CLARK .... Jan. 14, 1890
City Engineer, Meriden, Conn.

WILLIAM B. COCHRANE .... Jan. 14, 1890
Civil Engineer, Stamford, Conn.

THEODORE I. COE .... Jan. 9, 1900
Superintendent of Construction with Isaac Allen, Architect,
Hartford, Conn.

R. C. P. COGGESHALL .... June, 1887
Superintendent of Water Works, New Bedford, Mass.

HARRY C. COLLINS .... July 18, 1899
Collins & Norton, Engineers and Contractors, Springfield, Mass.

GEORGE K. CRANDALL .... Jan. 11, 1887
Civil Engineer and Surveyor, New London, Conn.

CHARLES M. CRAWFORD .... July 18, 1899
Secretary Hartford Paving and Construction Co., Hartford, Conn.

NORMAN McDONALD CRAWFORD .... July 18, 1899
General Manager Hartford Street Railway Co., Hartford, Conn.

FAYETTE S. CURTIS .... Jan. 9, 1900
Vice-President N. Y., N. H. & H. R. R., Boston, Mass.

THEODORE ALLEN CURTIS .... Aug. 14, 1900
Curtis & Johnson, Hartford, Conn.

LOREN E. DABOLL .... Jan. 8, 1895
City Surveyor, New London, Conn.

FRANCIS G. DANIELL, Associate Member .... April 20, 1901
Electrical Engineer, Oneonta, N. Y.

COURTLAND R. DARROW .... Jan. 8, 1895
With William G. Smith, Waterbury, Conn.

ARTHUR L. DAVIS .... July 18, 1899
Assistant Manager Eastern District and Export, American Bridge Co.,
100 Broadway, New York.

HENRY L. DAVIS .... Jan. 14, 1890
Civil Engineer, Wallingford, Conn.

HENRY DeB. FORBES .... April 20, 1901
Engineering Department N. Y., N. H. & H. R. R. Co., Bridgeport, Conn.

FREDERICK DePEYSTER .... Sept. 3, 1891
General Manager of the Brainerd, Shaler and Hall Quarry Co.,
Portland, Conn.

SOLOMON LeF. DEYO .... Jan. 9, 1900
Chief Engineer New York Rapid Transit Subway Construction Co.,
New York City, N. Y.

AUGUSTUS J. DuBOIS .... Jan. 9, 1900
Prof. Civil Engineering Sheffield Scientific School, Yale University,
New Haven, Conn.

FREDERICK J. EASTERBROOK .... March 30, 1900
Assistant Engineer N. Y., N. H. & H. R. R. Co., Bridgeport, Conn.

MALCOLM E. ECKHART .... Feb. 11, 1902
Derby Gas Works, Derby, Conn.

CHARLES W. EDDY .... Jan. 9, 1900
Assistant Engineer Wigwam Reservoir, Thomaston, Conn.

JAMES H. EDWARDS .... Jan. 10, 1899
With American Bridge Co., 7 West 22d street, New York.

FREDERICK H. ELLSWORTH .... March 30, 1900
Division Engineer N. Y., N. H. & H. R. R. Co., New Haven, Conn.

CHARLES H. EWING .... Jan. 9, 1900
Chief Engineer Central New England Railway, Hartford, Conn.

CHARLES A. FERRY .... Jan. 9, 1900
Civil Engineer and Surveyor, New Haven, Conn.

GEORGE D. FOOTE, Associate Member .... April 20, 1901
S. N. E. Telephone Co., New Haven, Conn.

FREDERICK L. FORD .... Jan. 12, 1897
City Engineer, Hartford, Conn.

THEODORE B. FORD .... April 20, 1901
Civil Engineer, Bridgeport, Conn.

WILL H. FULTON .... Jan. 8, 1901
Civil Engineer, New Haven, Conn.

EDWARD GAGEL .... Jan. 9, 1900
Division Engineer N. Y., N. H. & H. R. R. Co., West Haven, Conn.

CHRISTOPHER M. GALLUP .... Jan. 10, 1899
City Engineer's Office, Hartford, Conn.

GEORGE W. F. GILLETTE .... Jan. 9, 1900
City Engineer's Office, New Haven, Conn.

HENRY H. GLADDING .... Jan. 9, 1900
Assistant City Engineer, New Haven, Conn.

EDWARD O. GOSS .... Nov. 29, 1890
Assistant Treasurer Scovil Mfg. Co., Waterbury, Conn.

EDWIN D. GRAVES .... Oct. 25, 1895
Chief Engineer Conn. River Bridge and Highway District,
Hartford, Conn.

A. CLARK HALL .... Jan. 8, 1901
Transitman Hartford Water Department, West Hartford, Conn.

JAMES S. HALL .... Jan. 10, 1899
City Engineer, Ansonia, Conn.

MORRISON C. HAMILTON .... Jan. 9, 1900
With N. Y., N. H. & H. R. R. Co., Hartford, Conn.

BENJAMIN F. HATHAWAY .... Aug. 14, 1900
Stamford, Conn.

ARTHUR S. HAWLEY .... Feb. 11, 1902
Civil Engineer, Hartford, Conn.

LOUIS R. HAZELTINE .... Feb. 11, 1902
Architect, 94 State street, New London, Conn.

N. F. HEFT .... Jan. 8, 1901
Superintendent Electrical Department N. Y., N. H. & H. R. R.,
Bridgeport, Conn.

JOHN T. HENDERSON .... July 18, 1899
Draftsman Conn. River Bridge and Highway District, Hartford, Conn.

ALBERT B. HILL .... Jan. 9, 1900
Civil and Consulting Engineer, New Haven, Conn.

FRANK E. HINE .... April 20, 1901
Civil Engineer, Fisher's Island, N. Y.

FRANK N. HOYT .... July 18, 1899
Civil Engineer Highway Commissioner's Office, Hartford, Conn.

ROBERT S. HULBERT .... Jan. 13, 1885
Civil Engineer and Surveyor, West Winsted, Conn.

BRADLEY H. HULL .... April, 1884
Civil and Hydraulic Engineer, Bridgeport, Conn.

C. M. INGERSOLL, JR. .... Jan. 8, 1901
Chief Engineer N. Y., N. H. & H. R. R., New Haven, Conn.

J. FREDERICK JACKSON .... Jan. 9, 1900
City Engineer's Office, New Haven, Conn.

CHARLES M. JARVIS .... April, 1884
Vice-President P. & F. Corbin, New Britain, Conn.

FRANK P. JOHNSON .... April 20, 1901
Manager Tidewater Traprock Co., East Haven, Conn.

WILLIAM D. JOHNSON .... Aug. 14, 1900
Architect, 926 Main street, Hartford, Conn.

WILLIAM E. JOHNSON .... Nov. 29, 1890
Engineer of Hartford Water Works, West Hartford, Conn.

HERBERT C. KEITH .... Jan. 9, 1900
Bridge Engineer Mason City & Fort Dodge R. R., Fort Dodge, Iowa.

HENRY J. KELLOGG .... April, 1884
First Assistant City Engineer, New Haven, Conn.

CASSIUS W. KELLY .... Jan. 9, 1900
City Engineer, New Haven, Conn.

RICHARD S. KIRBY .... March 30, 1900
Civil Engineer, Port Chester, N. Y.

FRANK H. KITCHEN .... Jan. 8, 1901
With Hartford Street Railway Co., Hartford, Conn.

HERBERT M. KNIGHT, ... Jan. 9, 1900
Constructing Engineer of the Continental Compressed Air Co.,
Norwich, Conn.

J. W. KNOWLTON ... Jan. 11, 1887
Civil Engineer, Bridgeport, Conn.

FREDERICK W. LAFORGE ... Jan. 13, 1885
Civil Engineer, Waterbury, Conn.

E. LE ROY LANE ... Jan. 8, 1901
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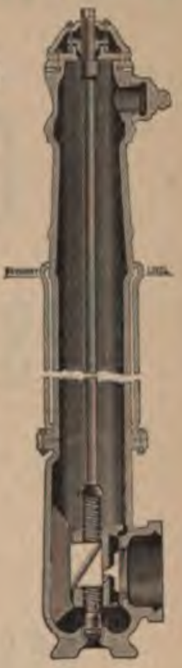

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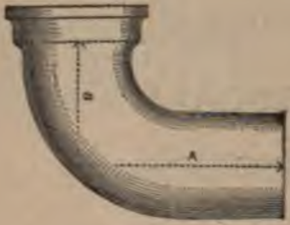

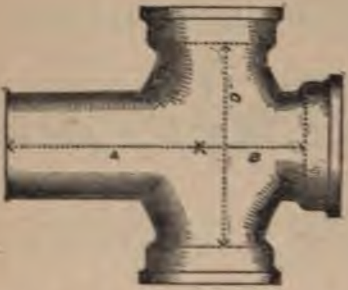

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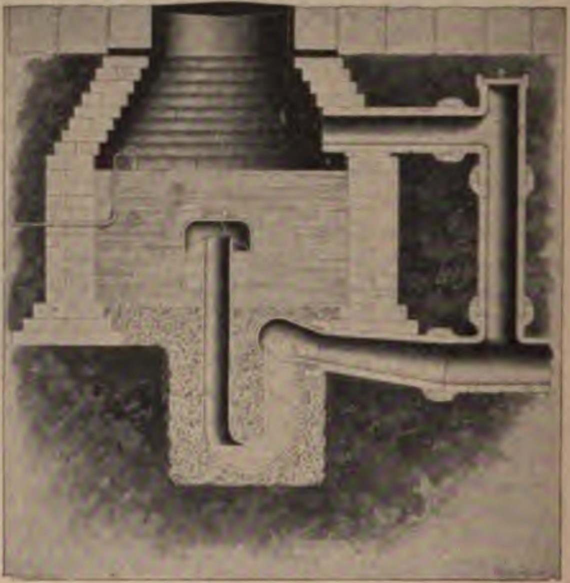

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Balance profit and loss	1,238,556.90		
Total receipts			$316,645,089.33
It has paid Death claims for		$109,759,365.91	
Endowments and annuities for		15,449,303.79	
for Surrendered Policies		26,691,442.17	
for Dividends		62,379,708.56	
A total returned to policy-holders or their beneficiaries, being 98.86 per cent. of the entire premiums received		$214,279,820.43	
It has paid for expenses, 9.13 per cent. of its income		28,911,657.70	
Taxes		10,804,028.28	
Total expenditures			$253,995,506.41
Balance net assets, January 1, 1902			$62,649,582.92
It has additional assets (see Statement)			2,627,596.29
Total assets			$65,277,179.21

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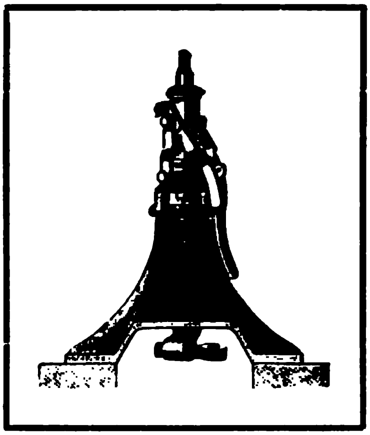

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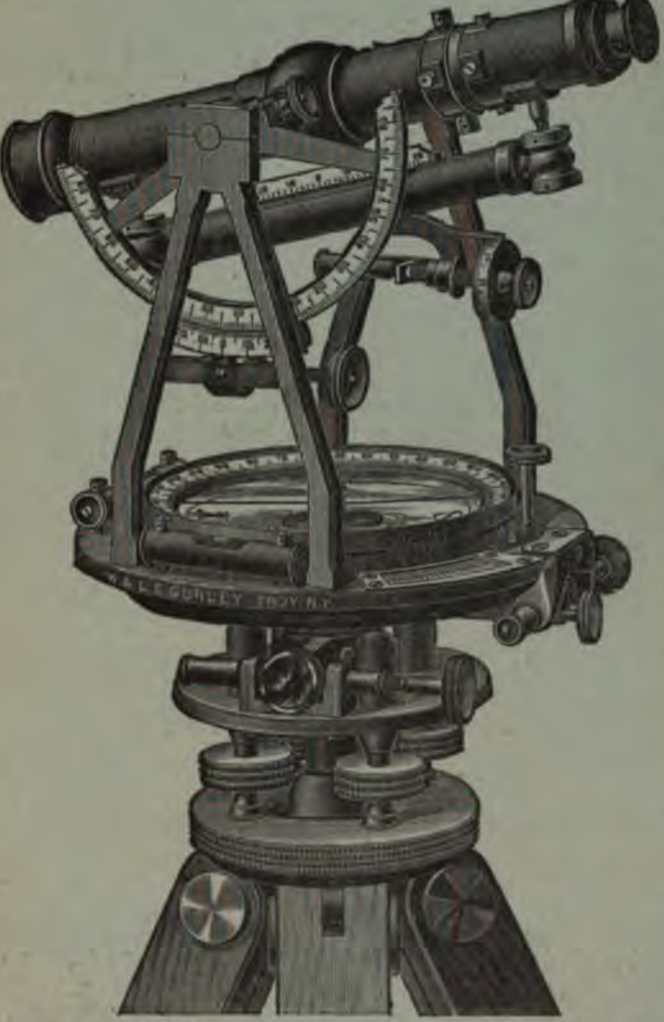
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